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ALL BANANAS WERE ONCE LIKE THIS

Fruit of *Musa martretiana*, an African species, natural size. It consists of little but seeds. All bananas, before they were cultivated, must have been very much like this—their worthlessness has led O. F. Cook to suppose that the plant was first cultivated for the sake of its roots. Then, when sterile fruit, containing more pulp and only rudimentary seeds, was produced as a result of chance hybridization, primitive man must have seized upon such a fortunate result and perpetuated it by suckers. (Frontispiece).

See "Origin of the Banana," p. 273

THE SCIENCE OF GENETICS

Too New to be Accurately Delimited—Represents an Empirical Study of Problems Which Have Been Treated Philosophically for Centuries—Its Importance to Agriculture—Its Application to the Improvement of the Human Stock.[1]

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THE science of genetics is so new that it is impossible to say at present just what it comprises and what its boundaries shall be. Until very recently, it did not even have a name, but the word "genetics", suggested by Professor William Bateson, has now been universally adopted. He says this word "sufficiently indicates that our labors are devoted to the elucidation of the phenomena of heredity and variation, in other words, to the physiology of descent, with implied bearing on the theoretical problems of the evolutionist and the systematist, and application to the practical problems of breeders, whether of animals or plants."

The science of genetics deals with evolution in all of its phases, as well as with the science and art of breeding. It makes contact with other sciences, especially biology, which lies at its foundation, as well as chemistry and sociology.

I think it may be truly said that in the development of the science of genetics our people, as human organisms, are more vitally concerned than in any other science. We look with great admiration, which becomes almost reverence, at the workers who are applying the physical and chemical sciences. But as great and wonderful as their achievements are, they do not necessarily concern all of the people.

Genetics, however, takes part in the life of every man, woman, or child, every plant or animal, in fact, every living thing. All organisms are the product of two forces acting together to determine what that individual shall be. Neither acts without the other and they are equally important. These are *environment* and *heredity*. Whatever we are or do, or whatever an animal or plant becomes, these two factors are constantly acting—the one, the external conditions surrounding us, the other the inherent constitution within us.

HEREDITY LONG OVERLOOKED.

Until very recently the factors which have received the greatest amount of study have been those of environment. We have looked upon plants and animals as controlled very largely by external forces, and even the study of man has centered around his environment, while the greatest force, heredity, has been largely overlooked.

The development of the study of this force has naturally been very slow, because it is more intangible, more subtle, more difficult to measure and determine accurately, than the more visible external conditions. The former cannot be measured in pounds, grams or degrees. It is impossible, furthermore, to draw a sharp line between heredity and environment and say exactly where one stops and the other begins. They are very closely linked together. To say which is more important in any organism requires very keen analysis and a history of the individual for many generations.

Nevertheless, problems of heredity and evolution have occupied the minds of men from the beginning, although any conclusions reached have been largely speculative and not based directly or indirectly upon experimental data. "It is true that until 1858, when

[1]Paper no. 44, Department of Plant Breeding, Cornell University, Ithaca, N. Y.

Darwin's Origin of Species was published, speculation far outran fact, and the development of the idea was at times arrested and even retrogressive. The Law of Evolution was reached not by any decided leap, but by the progressive development of every subordinate idea connected with it, until it was recognized as a whole by Lamarck, or later by Darwin."

Many evolutionary ideas trace back to Greek natural history literature, which from beginning to end is a continuous source of pleasure and surprise. Amid wide differences of opinion as to how far the Greeks actually anticipated later discoveries, the true conclusion is that they anticipated many of our modern theories by suggestion; thus they carried the idea of evolution well into its suggestive stage, which was so much ground gained for those who took it up in Europe. Greek speculations greatly hastened the final result, although judged by modern scientific standards they arose mainly as a series of happy conjectures.

As early as six hundred years before Christ, Anaximander wrote that the earth was, at first, a fluid. Gradually this fluid began to dry and grow thicker, and here and there dry land appeared. When this dry land had become firm enough to serve as his home, man came up from the water in the form of a fish. Slowly and gradually the fishes, struggling about on the land, gained for themselves the limbs and organs they needed for their new situation, and their development into men.

After them, other animals came up in much the same way, then the plants, until the whole world was clothed with its present inhabitants.

THE GENETICS OF EMPEDOCLES.

Empedocles, a century and a half later, added a new thought. He said that in the beginning there were all sorts of strange, incomplete, and misjointed monsters which swarmed upon the earth, having sprung up and out of the earth itself. Each was a chaos of limbs which were to belong afterward to other animals which needed them more. An interchanging came about slowly and gradually by which appropriate limbs fastened themselves to the proper animals. The last of these mis ointed creatures is the one known as the centaur, half man, half horse. After a while, when all of the members had found their proper places, the animals were complete.

Later came Anaxagoras, who was the first to believe that there was intelligent design back of the creation of animals and plants. He believed there had originally been a slime in which there was mixed, in a chaos, the germs of all the later plants, animals and minerals. Out of this mixture, order slowly arose by the minerals settling first, forming the earth, with the air floating over it and the ether above. The germs of plants settled out of the air upon the earth and vegetation covered the mineral floor. From the ether came the germs of animals and men.

The greatest scientific thinker of early Greece was Aristotle. He had spent his life by the seashore and knew better than any other man of his time the exquisite seaweeds and still more beautiful marine animals. He was the first to think of them as a related series, the higher developing out of the lower under the pressure of what is called a perfecting principle. Out of the inanimate rocks had sprung the marine plants—the seaweeds. From these had developed first "plant animals" like the sea-anemones and the sponges. These grew attached to the rocks, as plants do. With higher development came locomotion with ever increasing energy. At last man arose, the Crown of all Creation.

During the long middle ages, the evolutionary idea made no advance. Finally it began to retrogress, when Greek natural philosophy shared in the general suppression of the rationalistic movement of thought of Arabic origin. Later the hard and fast conceptions and definitions of species developed in the rapid rise of systematic botany and zoology, and were grafted upon the Mosaic account of the Creation, establishing a Special Creation theory for the origin of each species. Later still, when it was discovered in paleontology that species of different kinds had succeeded each other in time, the "special"

THE FIRST MUTATION ON RECORD

At the right is the Greater Celandine (*Chelidonium majus*) a plant of the poppy family found in Great Britian and throughout Europe. At the left is a "sport," or mutant form, markedly different in the shape of the leaves, which appeared in 1590. Such sudden changes or mutations in plants and animals have been widely studied since the declaration of De Vries, at the beginning of this century, that evolution was mainly due to them; and they are still the subject of continual debate among genetists. Their origin is so mysterious that many biologists think they may be merely the effects of undiscovered hybridization in the ancestry of the plant producing them. All attempts to produce mutations experimentally have failed. (Fig. 1.)

theory was again remodeled to cover a succession of creations extending down almost to the present day.

After the middle ages, evolutionary theories were again revived, first by the natural philosophers and rashly speculative writers and finally by the working and observing naturalists. The climax was reached in the work of Lamarck and finally of that greatest of naturalists and philosophers, Charles Darwin.

THE INFLUENCE OF DARWIN.

The publication of the "Origin of Species" had a profound influence upon thought in all fields of human learning, but more especially in biology. The work of Darwin made such a deep impression upon biologists, in fact, that problems of evolution were considered to be settled for all time. For nearly thirty years inquiry into the methods of evolution was almost at a standstill.

This long silence was broken, however, in 1900, when Hugo De Vries, a Dutch botanist, published his monumental work, "Die Mutations Theorie." Many years before, it had seemed to De Vries that Darwin's hypothesis of the origin of species by natural selection and the gradual accumulation of variations was inadequate to explain all of the facts, and that the method of origin as postulated by Darwin was too slow to account for the origin of our present species within geological time. For the purpose of proving whether

this was true or not De Vries began a series of carefully planned experiments to demonstrate whether species may be produced experimentally. These tests and many subsequent observations demonstrated that species-formation is not always a slow and gradual process, but that new species may be formed at a single step.

These experiments have had great influence in stimulating research in genetics, not by the Darwinian method of collecting facts, but by carefully planned experiments with their proper checks. De Vries' reputation, indeed, will last longest not from his elaboration of the mutation theory, which was already suggested by Darwin, but by his introduction of the experimental method into the study of evolution. To the worker in practical genetics the experiments of De Vries also have great value. By dealing with vast numbers of plants or animals the breeder seeks to discover the mutants, as De Vries called the suddenly appearing new forms, or exceptional individuals, and produce new and valuable races from them.

PRESENT POSITION OF GENETICS.

The new science of genetics holds today a very prominent place among its sister sciences. Around it are clustered many great problems now occupying the attention of thoughtful men, while upon it is based the practice of the producer of animals or plants to bring forth better varieties and strains for the use of mankind. Problems of eugenics, furthermore, are receiving wide consideration, and in order to be sane and in accordance with the laws of Nature, they must be kept close to the foundation principles of genetics.

The laws of heredity were applied empirically by the shepherds of the flocks and the tillers of the fields centuries before their full import was known. Scientific and philosophic minds have long sought to solve the problems involved in the apparently simple truths, "like begets like", and "the sins of the fathers shall be visited upon the children unto the third and fourth generations." From the sum total of this knowledge, empirical and scientific, practical and theoretical, has been evolved much of definite significance concerning racial and individual development. But the most important and most attractive single contribution was the mathematical formula of heredity discovered by Gregor Mendel half a century ago. It is not exaggerated to speak of his discovery as leading into a new world, the very existence of which was unsuspected before.

"In research as in all business of exploration, the stirring times come when a fresh region is suddenly unlocked by the discovery of a new key. The conquest is easy and there are prizes for all. We are happy in that during our own time not a few of such territories have been revealed to the vision of mankind." "I do not dare to suggest," says Bateson, "that in magnitude or splendor the field of genetics may be compared with that now being disclosed to the physicist or the astronomer; for the glory of the celestial is one and the glory of the terrestrial is another. But I will say that for once, to the man of ordinary power who cannot venture into those heights beyond, Mendel's clue has shown a way into a realm of nature which for surprising novelty and adventure is hardly to be excelled."

To Gregor Mendel, monk and abbott, belongs the credit of founding the modern science of heredity. Through him there was brought into these problems an entirely new idea, a fresh conception of the nature of living things. Mendel demonstrated by a carefully planned series of experiments that plants and animals are not indivisible entities, but that every individual contains an enormously large number of smaller units, each separately heritable. And furthermore, he demonstrated that these units are transmitted in a definite and regular manner.

GREGOR MENDEL'S INFLUENCE.

The rediscovery of Mendel's Law some fourteen years ago has led to a complete change in our attitude towards the problems of variation, heredity and evolution; and the new method of study thus introduced has rendered possible a renewal of the attack upon these problems with renewed vigor and with remarkable results.

In systematizing any body of facts to form a science, it is first necessary to determine the underlying units out of which the facts are made up. Alchemy could not become chemistry until its fundamental units were discovered and identified. So the science of genetics could not exist until the conception was developed that the individual is made up of smaller heritable units called "unit characters." Thus we are concerned with the inheritance of unit characters and not with the individual as a whole. This gives us a method of analysis hitherto little employed in biology.

The observed phenomenon of variation is merely the manifestation of different combinations of these unit characters. Obviously, when individuals are made up of many unit characters, say five hundred to a thousand, the possible combinations of these units are almost limitless and thus there appears the variability which we observe.

The external manifestation of a plant or animal is, furthermore, little criterion of its actual genetic composition. Animals may be the same in appearance but differ widely in their offspring. Gray rabbits, for example, may be synthetically produced by bringing together a number of entirely different combinations of unit characters. Yet these gray rabbits look the same. Every organism has its peculiar formulae of body cells and germ cells, or as genetists say, its own genotypic and phenotypic formulae.

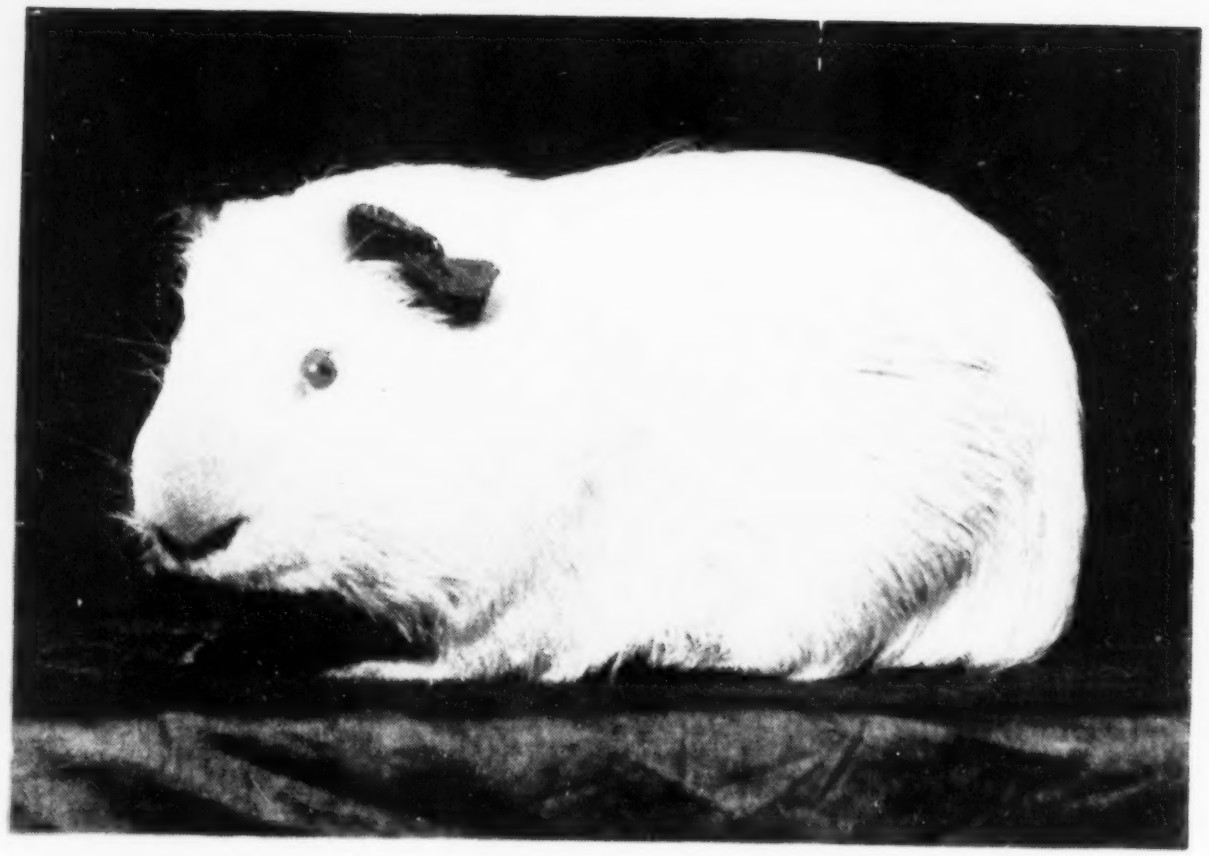
This principle was recognized many years ago by Jordan of France, who believed that species should be classified according to their method of transmission and not according to their external appearance. Thus we have the so-called "Jordan's Species."

THE QUESTION OF "PURE LINES."

Another problem which is puzzling the genetist at present is the theory of the pure line, projected by Johannsen. This deals with another phase of the unit character idea. If all organisms are made up of unit characters, these must exist as homogeneous combinations or heterogeneous ones. The offspring of a self-fertilized plant having similar unit characters is called a "pure line." According to this theory, the process of selection as we ordinarily consider it is a process of isolating pure lines. When this is done, according to Johannsen, no further progress in changing the race is possible unless a mutation or the sudden manifestation of a new unit-character appears. According to this notion, selection is a process of isolation and elimination and has no power to cause advancement. This leads us to consider another and greater problem, perhaps the greatest of all—the cause of variation and mutation.

If evolution takes place by the appearance of new unit characters or mutations—where do these come from? and can they be controlled? This is the eternal mystery. Experiments give us little clue. Many experimental attempts have been made to produce mutations but all have failed. All apparent successes have turned out to be illusory, when subjected to rigid tests. Most have proved to be not new characters at all, but merely new combinations of old ones. Of course, we can produce such new combinations, in many cases, at will, but that is a far different thing from actually producing a new character. At present, our only means for getting a new character is to sit down and wait until it appears—whence or how we know not. Even when it has appeared in this way, it is quite as likely to disappear again, if it proves disadvantageous to the individual carrying it. In such an event natural selection eliminates it (by destroying the individual carrying it)—unless it should happen to be useful to man. In the latter case, we artificially preserve it by removing the individual carrying it from competition with its wild relatives, and putting it to our own use. That is why domesticated races of animals or plants differ from their wild relatives.

One of the greatest problems, even yet, before the student of genetics is that much discussed subject, the inheritance of acquired characters. Are the qualities which an organism receives during its lifetime passed on to its offspring? If so, by what mechanism is



THE SIMPLEST EXPRESSION OF MENDEL'S LAW

The Austrian monk, Gregor Mendel, was the first man to express the laws of heredity as mathematical formulae, a method which genetists are now attempting to apply in every possible field. Such formulae can be developed only as a result of experiments on a large scale, which in Mendel's case were conducted with garden peas. Another application of the simplest of his formulae is shown in these photographs of guinea pigs bred by W. E. Castle. The character "black" is *dominant* to the character "white," which is therefore called *recessive*. When a white and black guinea pig are bred together (upper left and right) all the offspring will be black. If the members of this (first filial or F1) generation are bred together (lower left), however, it is found that *segregation* of the characters takes place in the second filial (F2) generation, according to the mathematical laws of chance, so that in the F2 generation the proportion of black to white individuals is 3:1. Further breeding shows the white animal to be pure for that character, and one of the blacks to be pure; the other two blacks (in general terms 50% of the F2 generation) are found to have white as well as black in their germ-cells, and bred together will again give the 3:1 ratio. (Fig. 2.)

this done? These are the ever-present questions which have been worn threadbare by biologists and evolutionists who have based their so-called arguments upon philosophical speculations and have not arrived at these conclusions as the result of experimentation. The present tendency of genetics, however, is to base its conclusions upon the results of controlled experimentation only, and the empirical method is being applied to this time-honored controversy with the hope of obtaining something tangible and definite.

To prove experimentally the inheritance of acquired characters, suggests Walter, three things are necessary: first, a particular variation must be called forth by a known external cause; second, it must be something new and not merely the awakening of latent qualities; and third, this induced variation must exist and reappear in subsequent generations after the original exciting cause has been removed. Up to the present the so-called "acquired characters" which seem to be inherited have failed to fulfill all of the requirements.

COMMERCIAL VALUE OF GENETICS.

The thrill of discovery is not dulled by a suspicion that the discovery can be commercially applied. "With rarest exception the discoveries which have formed the basis of physical progress have been made without any thought but for the gratification of curiosity. Of this there are few examples more conspicuous than the work of Gregor Mendel. Untroubled by any itch to make potatoes larger or bread cheaper, he set himself in the quiet of a cloister garden to find out the laws of hybridity, and so struck a mine of truth, inexhaustible in brilliancy and profit."

Nevertheless, the work of Mendel had very great practical application. The discovery known as Mendel's Law enables the breeder, if given sufficient time, to construct an animal or plant almost at will. He can take a bit here and a bit there and by hybridization unite them to produce whatever is desired. For example, suppose there is desired on the market a plant with a red flower, dwarf stature and smooth leaves. A breeder goes about the production of this plant by taking a variety containing the red color and another variety having the dwarf stature and crossing them together. When the hybrid is produced, he crosses that with a third parent having smooth leaves. As a result, he will have brought together in some one of the offspring all of the qualities desired.

You will see that the claims put forth by students of genetics are high, but I hope to be able to show you that their claims are not unfounded. Any body of science has immediately an added fascination when its supporters are aware that their labors are somewhat in the main stream of progress. The science of genetics can boast of this position.

With an understanding of the facts of transmission of plant characters from generation to generation, we are enabled to control the forces of heredity almost at will. Biologists are learning how to harness and use heredity as electricians are learning how to harness and use electricity. The one uses the great network of heredity by taking a bit here and a bit there and putting them together, creating a valuable new plant or animal, the other takes our waterfalls which have little use and converts them into greater sources of power for the benefit of mankind.

Hays says, "It is fair to estimate that, of the twenty-seven billion dollars of our annual national production, electricity and breeding may each be credited with one billion dollars. It is also reasonable to expect that each will have added another billion annually by the time our total production reaches thirty-seven billion dollars. As countless waterfalls along our streams are waiting for the electrical engineer to bring them into service of man, so the choicest blood streams of heredity in the various species of plants and of animals are waiting for the plant breeder or the animal breeder to segregate them and make them available."

Scientific breeders believe that every species is amenable to improvement by breeding; that every species has in it individuals with rare value for producing progeny along desired lines. Breed-

ing power, projected efficiency, or the power of the individual plant or animal to beget valuable progeny, has come forward as a central idea in plant and animal breeding. Careful breeders are searching each species for the occasional, the phenomenal individual—when that one in many thousands is found, all the rest are discarded. This individual of superior blood is then multiplied and sent to the growers to take the place of their half-civilized kinds, and thus these varieties are superseded by the improved kind. This is the method of improving plants and animals by simple selection.

Breeders have worked out a yet more radical method of producing improved varieties, the method of crossing or hybridization, followed by selection. Once those rare forms with heredity strongest in the lines in which improvement is desired are secured, new and more pronounced varieties are created by bringing together from widely separated sources, those of the same variety, and crossing or hybridizing them. The resulting progeny diverge, or vary, more widely than the progeny of forms more closely related. The exceptional individuals among these are searched out and tested, in the hope of securing an unusual or phenomenal individual of much stronger breeding ability than any found in either of the stocks used as parents of the cross. Thus is created an occasional plant or animal which combines the best in each parent stock and has the rare power of projecting this new combination of values into its progeny. To illustrate, Dr. William Saunders, of Canada, by crossing the two varieties of wheat known as Fife and Lagoda, produced Preston wheat, more valuable than either of its parents; Webber and Swingle, by crossing the sweet oranges with their wild relatives, produced valuable new species called citranges and tangelos; and Burbank, by hybridizing the black walnut and the English walnut produced hybrid walnuts of great value.

CHANCE FOR PRACTICAL MAN.

In the case of numerous species of plants, as wheat, flax, carnations and sugar beets, scientific breeders have already devised effective plans for ferreting out individuals with rare breeding ability along desired lines, and for thus creating new types or improving existing forms by using the subtle forces of heredity.

Such results are not beyond the practical breeder, as the history of countless varieties attests. In the middle of the last century, in France, Louis Vilmorin set out to increase the value of field beets as a forage crop. With strong faith in the unity of Nature, and the underlying principles of organic development, he seized upon some of the methods already in use in the production of blooded live stock, and adapted them to the production of "blooded" beets. This was a great departure in plant-breeding, and this method, elaborated and adapted by modern breeders, is one of fundamental importance in the creation of new types or the improvement of existing forms of life. Vilmorin's work with beets resulted in raising the sugar content of the sap from seven per cent. to 15 per cent. This change in the heredity of an humble plant was the basis of a new industry in France and in other European countries—the beet-sugar industry—and one which has now become thoroughly established in this country. The potency of that subtle character in Vilmorin's selected beet plants, chosen for their peculiar power to increase the sugar in the sap of their progeny, has added millions to the wealth of the world.

There is no lack of utility and direct application in the study of genetics. If we want to raise mangels that will not run to seed, or to produce a cow that will give more milk in less time, or milk with more butter and less water, we can turn to genetics with every hope that something can be done in these directions.

But the science of genetics is concerned with another field to which I have but briefly alluded—the field of eugenics, the improvement of the human stock. Eugenics is the application, to the human race, of the principles about which I have been speaking. This subject will be so well covered in the

Journal by experts better qualified than I, that I will say nothing more than to quote a few sentences from Professor Bateson. He says, "But here I would plead what I cannot but regard as a higher usefulness in our work. Genetic inquiry aims at providing knowledge that may bring certainty into a region of human affairs and conceptions which might have been supposed reserved for ages to be the domain of the visionary. We have long known that it was believed by some that our powers and conduct were dependent on our physical composition and that other schools have maintained that nurture, not nature, to use Galton's anthithesis had a preponderating influence on our careers; but as soon as it becomes common knowledge—not a philosophical speculation, but a certainty—that liability to a disease, or the power of resisting its attacks, addiction to a particular vice, or to superstition, is due to the presence or absence of a specific ingredient, and finally, that these characteristics are transmitted to the offspring according to definite, predicable rules, then man's view of his own nature, his conceptions of justice, in short his whole outlook on the world, must be profoundly changed. Yet as regards the more tangible of these physical and mental characteristics there can be little doubt that before many years have passed the laws of transmission will be expressible in simple formulae."

Two Contributions to Eugenics

The need which has long been recognized for compilation of the sources available for students of eugenics, is gradually being met. A. Edward Hamilton of the Extension Department, Eugenics Record Office, has published a paper in the Pedagogical Seminary, Vol. XXI, pp. 28-61 (March, 1914), in which he lists 100 of the most important works which have appeared, and precedes them with a full commentary, on chronological lines, which makes an excellent history of the progress of the science. The demand for a more complete bibliography has been largely satisfied by the publication of a bulletin of 131 pages by the State Board of Charities of New York, through its Bureau of Analysis and Investigation, in charge of Dr. Gertrude E. Hall. This Bibliography (Bulletin No. III, November, 1913) covers "Eugenics and Social Welfare," and is reasonably complete from a genetics point of view, while its cacogenics references are remarkably full.

German Progress in Genetics

An institution for the experimental study of heredity (Institut für Vererbungsforschung), the first of its kind in Germany, will be established in the next summer semester at the Royal Agricultural High School in Berlin. The Institute, which is divided into a zoological and a botanical section, comprises three acres of ground for experimental breeding, a row of greenhouses, and a building for laboratories. It will be built up on the remaining land of the High School in Potsdam during the course of the next year. Professor E. Baur, Ph.D., M.D., hitherto director of the Botanical Institute of the Royal Agricultural College, Berlin, has taken the direction of the new institution, while the zoological department will probably be entrusted to Dr. B. Klatt, *privatdozent* of the high school.—Mitt. der Deutsch. Landwirthsch. Ges.

COAT COLOR IN POINTER DOGS

Examination of Stud Book From Mendelian Viewpoint Suggests That Relation of Brown to Black is the Same in Dogs as in Other Small Mammals Which Have Been Investigated, and That There are Two Types of Yellow—Practical Breeding Rules.

C. C. Little

Bussey Institution, Forest Hills, Massachusetts.

THE time and expense necessary to conduct, on any considerable scale, a series of breeding experiments with pedigreed dogs, has led to few efforts to investigate the laws of inheritance in their case. The work done by geneticists with other small mammals has, however, shown that if Mendel's Law can be used successfully in the breeding of dogs, a large number of new and interesting forms might well be produced.

Since the actual breeding experiments with dogs are not likely to be undertaken for some time, the question naturally arises as to whether it is possible to obtain from already existing data any information which would be of use to the scientific breeder.

Knowing that the American Kennel Club has for years registered and recorded pedigreed and full-blooded dogs of almost every recognized breed, I obtained their stud book (Vols. 11-29 inclusive) to ascertain whether or not they contained available data on color inheritance. I found that in nearly every animal color was recorded, and that in several breeds the colors were simple and distinct enough to serve as fair material for tabulation. As E. N. Wentworth has recently pointed out in this journal, it is advisable to avoid, in so far as possible, stud book records which would be apt to be distorted as a result of favoritism to one color at the expense of one or more others.

After some hesitation, with this fact in mind, I chose pointers as a breed combining the greatest number of advantageous points with a minimum of disadvantageous ones. Some of the points may now be considered in detail.

ADVANTAGES OF THE MATERIAL.

First: The colors of pointers are distinct, being black, brown (liver), and yellow (lemon, orange or tan), on a white ground. Between these three colors—black, brown and yellow—there is little or no chance of confusion.

Second: The pointer is a well-established breed supposed to have been imported to England from Spain early in the eighteenth century, and then to have been crossed with the "brach" or the foxhound. From this cross the modern pointer is supposed to have been evolved by a process of inbreeding and selection. On the authority of Shields, a French encyclopedia, in defining the "brach" or "braque," states that it possessed the spotted coat, short hair and colors of the modern pointer; facts of considerable importance and evidence in favor of the braque as one of the ancestors of the pointer.

Third: No one of the colors is desired for breeding or showing to the exclusion of the others. Of course there are doubtless local preferences for one or the other color and these are probably well marked, but for the most part it can be said that pointers are as free from such preferences or prejudices as any other breed. It is at least sufficiently free from them to assure the absence of any wilful deceit in describing the color of any one animal. Lee, Compton and Westbrook all state that at the present time liver is the most popular color, then comes yellow next in favor, and

then black. That such is the case the relative proportions of the three records in the stud book seems to show.

STUD BOOK STATISTICS.

Stud book statistics are all of them open to the objection that, at their best, they represent part of the truth rather than the whole truth, in that the animals recorded are not the total count of offspring produced by any mating, but are rather those that reach saleable age or maturity and are reasonably close to the standard of the breed to which they belong. Such circumstances bring about a somewhat distorted view of the actual phenomena of inheritance in this case, but if proper allowance is made for probable inaccuracies it seems likely that stud book records of a standard organization like the American Kennel Club are accurate enough to give valuable statistics.

In collecting the data for this paper certain points had to be considered. Each mating of registered dogs was recorded on a separate card and filed according to the dam's registration number. On this card the offspring of the mating were recorded one by one as they were met with. No mating was used in compiling results unless it contained two or more offspring. Fully two-fifths of the pointers listed in the American Kennel Club stud book are from unregistered parents. None of these matings were recorded, since they were less valuable and less accurate in nature than those of registered parents. The earliest volumes of the stud book (Vols. 1-10) were not accessible to me from the same source as the later ones. This is not of any great importance, however, since the number of animals included in them is not large and since the chance of technical errors is undoubtedly greater in the earlier numbers than in the later ones.

LANG'S WORK WITH DOGS.

One of the few investigators to publish work on inheritance of dogs since the rediscovery of Mendel's Law is Professor A. Lang. Lang experimented with a pair of F1 hybrid dogs which he obtained through Herr Pfister-Kupfer.

The dogs thus obtained by Lang were black in color, and had been produced by crossing a brown-spotted female, somewhat hound-like in appearance, with a pure-bred black Newfoundland male. Fourteen puppies were thus produced, all of which were black in color. This is excellent evidence that black is epistatic to brown, thus coinciding with the work of many investigators of inheritance in mice, rabbits and guinea-pigs.

Lang wished to inbreed the F1 animals in order to ascertain whether or not alternative inheritance existed. If such was the case, brown puppies would reappear in the F2 generation. He therefore mated together his two F1 animals and obtained a litter of eight puppies. Of these, five were black and three brown, six to two being the theoretical Mendelian ratio in this case. This shows that in all probability, black and brown, in dogs, will follow the same order in inheritance that they do in mice and guinea-pigs.

A careful record of the extent of pigmentation also revealed that solid and spotted coat were, in all probability, a pair of Mendelizing units as they are in the other small mammals already investigated.

OBSERVED FACTS IN POINTERS.

If one turns to the case of pointers as recorded in the stud books, one finds this same pair of characters, black and brown, showing the same relation to each other. In pointers, as in most hounds and spaniels, brown is often spoken of as "liver." The brown or liver-colored dog is very distinct from black or any of its modifications, such as blue or gray. The nose and feet of the liver-colored dog are pigmented with rich chocolate brown pigment, with no trace of black pigment present.[1]

It is well known to breeders of dogs that yellows are of two very different types. This holds true in the case of pointers. One type is a bright, vivid yellow with *dark eyes and black nose.* The other type is duller and often lighter yellow *with pinkish-brown nose and light eyes.* The latter are considered inferior in many breeds and are, therefore, seldom

[1]In the table and test following, liver is used interchangeably with brown.

used for breeding purposes if it is possible to avoid them. The significance of these two types of yellow is already known in the case of rabbits and guinea-pigs and will, I believe, become apparent to all who breed dogs with an eye to testing the validity of Mendel's Law of heredity.

If we now turn to the tabulation of the matings of pointers from the American Kennel Club stud books, the following results are obtained:

Nature of Mating	Number of Matings	Color of Offspring		
		Black	Yellow	Liver
Liver x Liver	97	0	21	305
Black x Black	8	23	0	5
Yellow x Yellow	1	0	4	0
Black x Liver	56	77	9	95
Yellow x Liver	15	8	10	46
Yellow x Black	9	6	10	2
Totals	186	114	54	453

From an examination of this table it will be seen that liver appears to be hypostatic to black, and yellow, in turn, hypostatic to liver. We know, however, that there are two visibly different types of yellows and this, together with the facts stated above, suggests the hypothesis that we are here dealing with two pairs of Mendelian factors. These factors we may designate as:

B: The factor for black pigment which is absent from brown (liver) animals.

E: The factor for extension of brown and black pigment in the hair. In the presence of this factor, animals have spots of brown or black pigment on a white ground; in its absence the colored spots on the coat are yellow of various shades.

The table given above shows that black crossed with black produces occasionally brown young. On the other hand, brown crossed *inter se* give no black offspring in a total of over 300 young. This last mentioned type of mating does, however, produce some yellow young as well as brown ones. These facts seem to justify the conclusions as to the relative position of the various factors involved.

Hagedoorn has stated that, in the case of dachshunde, yellow is epistatic to black, that is to say that restriction of brown and black pigment is dominant over the extension of these pigments. This is a point of very great interest, for if carefully executed experiments could be carried out we should have a chance to investigate the behavior of a dominant and of a recessive yellow in forms that were perfectly fertile when crossed. This would afford an opportunity to obtain data of great importance on a point of considerable theoretical interest in genetics.

To return to the case of pointers, we should then expect to find the four following visibly different zygotic types.

1. BE—Black;
2. bE—Brown (liver);
3. Be—Yellow (black nose);
4. be—Yellow (brown nose).

We may now consider in detail certain matings which indicate the existence of these four types.

SOME INTERESTING MATINGS.

Type 1—Black. That black is of this constitution is shown first by the black x black matings (see table) which produce liver young; and second, by the fact that black by liver may produce yellow young. The appearance of these two hypostatic forms in crosses in which at least one parent is black, and the fact that no black animals are formed as the result of mating liver x liver or yellow x yellow, show that blacks possess factors which both yellows and livers lack.

Type 2—Brown. That these animals lack the factor B is shown by the fact

that they have not the ability to produce blacks when mated *inter se*; while the formation of yellows in liver by liver matings shows that liver animals may possess the factor E in half or all their gametes.

Types 3 and 4—Yellow. The distinctness of these two types of yellow is seen by the following matings:

Female 40471 yellow was crossed with male 47940 liver. It is known from the 97 matings of liver-colored animals that no liver-colored animal can carry the factor for black. If this mating produced any black young, therefore, it would be certain that it was the yellow parent; in this case female 40741 that carried the factor for black. The actual result was seven brown, five yellow, and *six black young*. The yellow parent was accordingly of the formula Be.

The other type of yellow is seen in a mating between female 46990 yellow and male 54357 brown, which gave only brown (liver) young, eight in number. Here the yellow parent was of the formula *be*.

In the case of certain animals it is possible to form a more or less definite idea of their gametic constitution. Thus, for example, male 41525, black, is undoubtedly BbEe in formula. When crossed with females of formula bbEE (homozygous liver), he has sired 10 black and 16 liver-colored puppies, the Mendelian expectation being equal numbers of these two colors. When crossed with yellow females he has sired four yellow and six non-yellow young, equality being again expected. When crossed with liver-colored females heterozygous in E (formula bbEe), he has sired eight blacks, two browns and three yellows. In this case a 9:3:4 ratio is expected.

Another famous sire, 40708 black, is probably of the formula BbEE. Thus, when crossed with brown females, he has sired 17 black and nine brown young; 13 black to 13 brown being the theoretical proportions. When crossed with a yellow female he has given a total of seven young, all non-yellow in character.

IMPORTANT PRACTICAL POINTS.

Several points of importance to the practical breeder now became apparent. In order to purify a strain from black individuals it is only necessary to go on breeding liver to liver and yellow to yellow indefinitely. As long as this is carefully done there should be no blacks produced. Yellows from two liver parents may safely be crossed with liver-colored animals. If, however, any other yellows are used, the breeder may expect a certain number of black young among the progeny. To obtain a pure black strain is not so simple, requiring for its certain completion a separate breeding test for each black individual by crossing it with yellows coming from two liver parents. If among the progeny any liver or yellow young are found, it is certain that the black in question is not of the formula BBEE, and will, therefore, not breed true. Among the liver animals there should theoretically be found two types; one homozygous for the factor E and one heterozygous for this factor. The former type should in crosses with yellows produce only non-yellow young. To this class belong the following liver animals, 54357, 52793 and 47456, which have produced by yellow mates, eight, six and five liver-colored young respectively. The other type of liver animal carrying yellow as a recessive, is seen in such animals as 44135 and 41348. These animals when mated to yellows have produced a total of three liver and two yellow young, the Mendelian expectation being equal numbers.

Before considering the data in this paper as conclusive, breeding experiments should be made. The writer believes, however, that the data is worthy of publication, since it hints strongly that the methods of color breeding, used so successfully in the case of the smaller mammals, may be of value in breeding dogs. It also shows that the stud books of the American Kennel Club may be used as a source of information as to color inheritance in the case of several breeds of dogs. In addition it shows tentatively that there is a recessive type of yellow dog, analogous to the recessive yellow of guinea-pigs; and that the relation of brown to black is the same in dogs as in the other small mammals in which the matter has been experimentally investigated.

In closing I wish to express my indebtedness to my father, James L. Little, for the chance to use the American Kennel Club stud books, and to my wife, Katharine D. Little, for her assistance in collecting the data and in preparing the paper for press.

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Eugenics Program in Utah

Dr. Frank M. Driggs, superintendent of the Utah School for Deaf and Blind, was elected president of the Utah Eugenics Society, at its annual meeting in Salt Lake City during April. The following papers were read: Eugenics and the Nation, by Mathonihah Thomas; Eugenics and the Profession, by Dr. J. Edward Day; Popular Misconceptions of Eugenics, by Dr. Joseph Peterson; Menace of Social Diseases, by Dr. W. R. Tyndale; Reforms Eugenics Can Not Accomplish, by Dr. E. G. Peterson; Eugenics and Legislation, by J. C. Wheelon; Education for Parenthood, by Dr. Ada E. Faust. The secretary, Dr. E. G. Titus, of the University of Utah, writes:

"The general trend of the discussions was all to the effect that we are not ready for many of the odd and peculiar bills which have created enthsiasm in several of the states. That is, it is much better at the present time to devote our energies to education along eugenics lines, endeavoring to reach all the people possible and give them an idea of what we consider a proper trend of eugenics; to have all the lectures possible delivered before schools, church organizations and other general assemblies; to endeavor to secure cooperation of libraries in order that they may introduce eugenics books; to secure the cooperation of the various woman's clubs especially those belonging to the Utah Federation of Woman's Clubs, and if possible, to secure at least one place on the program of each club for the coming year; to endeavor to secure better care and protection for the classes of people who are unable to properly care for themselves."

Benefits of Eugenics

The effects of eugenic reform, if successful, would be to lower taxation, to raise real wages, to facilitate commercial competition, and to increase the security of the country in time of war. In things wholly immaterial, great benefits would moreover be felt; for a diminution in the number of the insane, the feebleminded, the criminal, and the wastrels annually brought into the world would mean the removal of a terrible burden of unmerited misery; whilst an increase in the output of men and women of character and ability would not only add to the reputation of our country, but would also add to its happiness in many ways. These are the benefits we hold to be in the power of this generation to bestow on our country in the future by now resolutely grappling with the problem of human heredity.—Extract from presidential address (1913) of Major Leonard Darwin before the Eugenics Education Society, London.

FACES AND RACES

VERNON L. KELLOGG
Stanford University, California.

THE Mid-Pacific Institute of Honolulu is the result of the amalgamation in 1910 of several boarding and mission schools for boys and girls. Oldest of its included schools is the Kawaiahao Seminary, primarily intended for the education of Hawaiian young women and girls. It was founded in 1846 and has a record of much effective and beneficial work. But its pupils are by no means all Hawaiian although they are all, for the moment, of Hawaii. This is strikingly shown by the photograph, reproduced herewith, of 26 of the 127 girls now in the Seminary.

This interesting photograph, which was made by Miss Roselle F. Faast, one of the teachers in the school, is rendered accessible to the readers of the Journal of Heredity by the kindness of E. M. Ehrhorn, entomological superintendent of the Hawaiian Board of Agriculture, who sent it to me recently with the data of the races and race mixtures represented by the faces pictured in it.

The grouping for the photograph was made by Miss Faast for the sake of picturing the extraordinary melange of races represented in the school, and includes, with one exception, all of the pure and mixed race types occurring in it. It reveals, therefore, the extraordinary conditions in a school under the American flag in which every fifth student is of different race or race mixture. More than that, some of these mixtures are of most unusual character, as Irish-Chinese-Hawaiian, and Alaskan Indian-Japanese-Hawaiian, and Guam-French-Mexican.

The faces in the photograph are so clear, and the racial traits so well shown, that its careful study under a reading glass (granted that it does not lose too much of its sharpness of definition in the process of reproduction) will enable any interested reader to determine for himself, in some measure, the dominating characteristics in these results of certain experimental human hybridizations.

The distribution of the parentage of numbers 16, 17, 23 and 25, which are given in the caption of the illustration as including three races each, is as follows:

No. 16: Father, half Alaskan Indian, half Hawaiian; mother, half Japanese, half Hawaiian.

No. 17: Father half Portuguese and half Hawaiian; mother, half French and half Hawaiian.

No. 23: Father, pure Guam; mother, half Chinese and half Hawaiian.

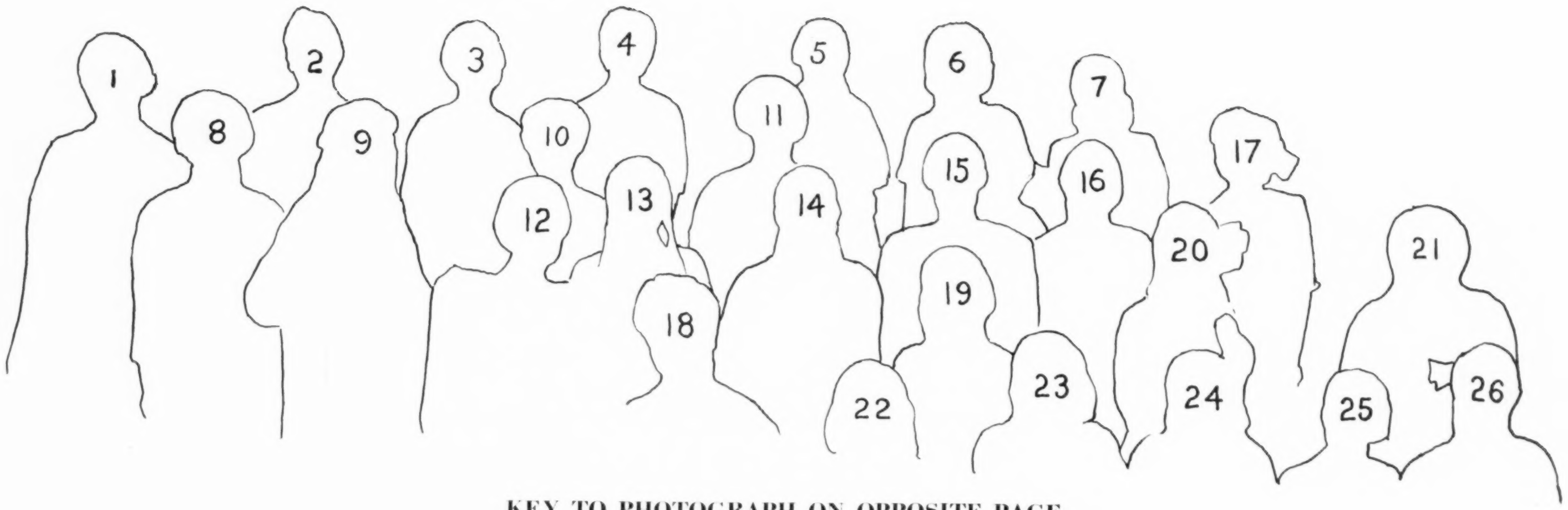
No. 25: Father, Irish; mother, half Chinese and half Hawaiian.

A POLYNESIAN-NORWEGIAN METISSE

THE EDITOR.

THE behavior of the Polynesian stock, when crossed with a Germanic one, is more plainly shown in the accompanying photograph by Miss Faast of a girl of South Sea (Nauru)-Norwegian ancestry, who is also included in the group picture (No. 15).

The Polynesian race, which is widely scattered over the South Pacific, is a comparatively late arrival, having spread throughout the islands in successive migrations since the Christian era, and up to historic times—the largest of these waves may have taken rise in the fifth century. It is now



KEY TO PHOTOGRAPH ON OPPOSITE PAGE

Twenty-six of the 127 girls in Kawaiahao Seminary at Honolulu, T. H., each of a different race. One other mixture which might have been included —English-Hawaiian—was inadvertently omitted from the group. The racial stocks of the girls here shown are as follows:

1. Korean.
2. Spanish–Hawaiian.
3. Norwegian–Hawaiian.
4. Scotch–Hawaiian.
5. American.
6. German–Hawaiian.
7. Chinese–Portuguese.
8. Chinese.
9. Hawaiian.
10. Porto Rican–Spanish.
11. German.
12. Filipino.
13. Chinese–Hawaiian.
14. Spanish-Portuguese.
15. South Sea (Nauru)–Norwegian.
16. Japanese–Alaskan Indian–Hawaiian.
17. French–Hawaiian–Portuguese.
18. Japanese.
19. Swedish–Hawaiian.
20. American–Hawaiian.
21. Portuguese–Hawaiian.
22. Filipino–Portuguese.
23. Guam–Mexican–French.
24. Irish–Hawaiian.
25. Irish–Chinese–Hawaiian.
26. Portuguese.

Fig. 3

NORWEGIAN-POLYNESIAN GIRL

Unions between European men and native women are common in the South Seas, and according to the missionary, George Brown, they are, in Samoa at least, more fertile than those between natives. The offspring is characterized by exceptional vigor, in accordance with the law of hybridizing so familiar to those who work with plants and animals; there seems to be insufficient evidence as to the value of succeeding generations. The cross in this case is not a very "wide" one, according to De Quatrefages' analysis of the Polynesian race, but it appears that most of the noticeable Polynesian traits are dominant over those of the Norwegian father. (Fig. 4.)

pretty generally agreed that the race is of Malayan origin, although it reveals traces of other strains of blood, not now found in the Malay archipelago.

"This is evident in their physical appearance", says Daniel G. Brinton, in "Races and Peoples." "They are uncommonly tall, symmetrical and handsome, a stature over six feet not being unusual among them. Their features are regular, their color a light brown. Their hair is black, smooth and glossy, sometimes with a crisp or curl in it, which betrays a touch of Papuan blood."

This Papuan blood was probably gained while the race inhabited the small island of Buru or Boru, between

Celebes and Papua, where the emigrants lived for a time after leaving their home in the western group of islands, according to Brinton. "Leaving Boru, they passed to the North of New Guinea (Papua), colonizing the Caroline and Solomon Islands, but their vanguard pressing forward to take possession of Savai in the Samoan group and Tonga to its south. These two islands formed a second center of distribution over the western Pacific. The Maoris of New Zealand moved from Tonga—'holy Tonga' as they call it in their songs—about 600 years ago. The Society Islanders migrated from Savai, and they in turn sent forth the population of the Marquesas, the Sandwich (Hawaiian) islands, and Easter Island."

ULTIMATE ORIGIN OF RACE.

As to the ultimate origin of the race, before its residence in the Malay archipelago, many hypotheses have been put forward, and there is scarcely data available, it seems, to raise any of these above the level of a hypothesis. On the basis of a supposed large Semitic element in the Polynesian language, it has been alleged that they came from Arabia; the most generally received opinion, however, is probably one which places their first home in southeastern Asia.

The French anthropologist, De Quatrefages, held that the Polynesians were essentially a hybrid race, and sustained his thesis as follows:[1]

"Everything indicates that the Polynesian race is a mixed race, that is, that it has been formed by means of crosses between populations which differed widely in their physical characteristics.

"Furthermore, all the facts indicate that this race is the product of elements borrowed from the three fundamental types, white, black and yellow, and this preliminary proposition, which all our later study will confirm, shows itself at once and clearly in a study of the traits which characterize the Polynesians."

"In a Tahitian head which belongs to the Museum, and which may be considered as an excellent type of the race, the skull, properly speaking, is high, moderately elongated from back to front; the curve which it describes from forehead to occiput is at first regular, but suddenly flattened at the back. The parietal prominences at the sides of the head are not very pronounced. The forehead is rather receding, although the frontal bone is well developed. The orbits are moderately far apart, the cheek bones slightly prominent, the bones of the nose raised and of medium development. The upper jaw is slightly protruding, in other words it is a little bit prognathous, and presents a somewhat massive appearance; the lower jaw is curved below and presents a prognathism that is little marked.

"The ensemble which I have just sketched indicates a fusion of the characters which one finds among the white, yellow and black races. They modify and efface each other reciprocally.

"On the other hand, we find in other skulls much more accentuated traits. In one, belonging to a native of the Marquesas islands, the general form of the skull approaches that of the Hindu; the forehead is raised, the nose more prominent, the upper jaw is hollowed, and the lower one does not protrude.

"Here the characters of the white race are incontestably most evident.

"In still other skulls, coming either from the same locality or elsewhere, the skull is lengthened and narrowed, the bony ridges become more pronounced; the forehead is decidedly receding, the superciliary ridges very prominent, the cheek bones thrust forward; the nasal bones, small and concave, are welded together like those of the Hottentots; the protruding jaws and teeth are as marked as among pure negroes.

"Here the predominance of the Melanesian type[2] becomes indisputable.

[1] A De Quatrefages, "Les Polynesiens et Leurs Migrations," pp. 6-9, Paris.

[2] The word Melanesians is commonly used to designate the negroes who populate a part of the South Sea Islands. The double maxillary prognathism, that is, the protrusion of both jaws, is one of the traits which distinguishes them from the negroes of Africa, among whom the upper jaw alone presents this appearance, as a general thing. On the other hand, the negroes of Guinea have a double dental prognathism, while the negro of Oceania often has the teeth of the lower maxillary almost vertical.—De Quatrefages.

"If one passes from osteological characters to those furnished by the living man, we find a complete concordance. Generally the dome of the head is high, a little short from back to front, and flattened at the back [from artificial causes]. The forehead is well-developed, but ordinarily a little low; it often becomes beautiful, and the facial angle equals that of a European. The nose, although a little too short, and flattened by manipulation during infancy[3], is often straight and prominent too; in some islands, it is almost always aquiline, a character which belongs essentially to the white race. The eyes, rather small, are almost always horizontal, rarely oblique; and black in color. The cheek bones are prominent, but usually protrude forward, as with certain white populations, rather than on the sides. The mouth is well formed and its expression agreeable, although the lips are slightly too thick, and usually present that peculiar clamminess which indicates negro blood; but sometimes they are as fine and thin as those of a European. The chin often projects forward to an exaggerated degree, and then becomes narrow and pointed. The color of the skin varies from a very pale bistre yellow, recalling that of certain Southern Europeans, to a dark brown, which sometimes passes into a copper color. Finally the black or light or dark chestnut hair usually has a tendency to roll into curls and is often enough wavy but never woolly. The characters of the hair alone attest that the yellow element forms an inconsiderable part in the composition of the Polynesian race, for hair invariably black, straight and impossible to curl is one of the most general traits of Mongolian populations, without a single exception, to my knowledge.

"To sum up, the Polynesian race offers characters belonging individually to the white, yellow and black; but the influence of these respective ethnological elements is quite different. The yellow element hardly shows itself except in the color; it seems to have little part in the formation of the facial appearance. The black element has more effect on the face, and often tends to darken the color of the skin. To it also must be attributed the waviness or disposition to curl which the hair often shows. But the element which is by far the dominant, at least in a part of the population, is the white. This assertion will probably surprise many readers; nevertheless, all that is necessary to recognize it for true is to read the narratives of travelers, in particular those which complete the voyages of Dumont-d'Urville and his companions."

[3]A flat nose is a great perfection and beauty for a woman.—Moerenhout.

Bismarck's Heredity

The heredity of Prince Otto von Bismarck, the "Iron Chancellor," is studied by the genealogist Dr. St. Kekule von Stradonitz in the Mitt. der Zentralstelle f. deutsche Personen-und Familien-geschichte (Heft 7, 1910). The results are briefly as follows: Bismarck's paternal ancestry shows two peculiarities: A rather badly obscured line of ancestry, and a derivation through the female line from the famous field marshal Derfflinger. The maternal line is unbroken in its exhibition of literary character (the Mencke family); the maternal great-grandmother of Bismarck, wife of the younger Gottfried Ludwig Mencke, professor at Helmstadt, belongs to one of the most noted families of the period. But uncertain links are also found in her ancestry. The great-grandmother referred to was the grand-daughter of Johann Witten, syndic of the Damenstift of Gandersheim, and son-in-law of the chairman of the syndics, Michael Büttner. He is the most noteworthy figure in Bismarck's maternal line; he died in 1677. The account of this man, given by Dr. von Stradonitz, shows, as he says, a remarkable correspondence to the character of Bismarck himself. And when one follows back Bismarck's ancestry until he has included 128 of his progenitors, he is inclined to admit the author's explanation, that Bismarck was "the atavistic product of a cross between the Derfflinger and Michael Büttner strains of germ-plasm."

PUEBLO INDIAN MAIZE BREEDING

Varieties Specially Adapted to Arid Regions Developed by Hopis and Navajos—Their Work Not Sufficiently Appreciated—Probably Much Yet to be Learned from Them.

G. N. Collins
Botanist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

AMONG the many gifts that the white man received from the American Indian, maize is undoubtedly the most valuable. In the mythology of the Indian this cereal occupies a central position as the most important gift of the gods.

The power of minute observation commonly possessed by primitive people is highly developed in the agricultural Indian tribes of the Southwest. These Indians spend much of their time in their maize fields and it is only natural that the plant which supplies their principal food should come to be known in great detail. Every character of the plant, every operation in its cultivation and every stage in its growth are observed by the Indian with a minute attention in which he is seldom equalled by his white brother.

The ceremonies and care with which maize is cultivated by the Indians of the Southwest are well illustrated in a series of articles on "Zuni Breadstuff," by the late Frank Cushing, who showed that the importance of selection, care of seed, and cross-breeding, though not appreciated as such, are all given careful and conscious consideration by the Zunis.

According to Cushing, "In each corn-room or granary of Zuni, are preserved carefully, four objects; an ear of yellow corn full to the tip of perfect kernels, called a *yá-po-to;* an ear of white corn which has resulted from the intergrowth of two or more ears within a single husk-fold, called, from its disproportionate breadth and flatness, a *mi-k'iap-pan-ne;* a moderately large normal ear of corn which has been dipped by a Seed-Priest, in the waters of the great sacred Salt Lake far south of Zuni (*Las Salinas* of New Mexico), and a bunch of unbroken corn-soot. The latter two objects are laid side by side on the floor in the middle of the corn-room, and upon them also side by side, usually connected by a bandage of cotton filaments, the *yá-po-to* and the *mi-k'iap-pan-ne.*

"The significance of all this is both interesting and poetic. The corn-soot is held to symbolize the 'generation of life,' the salted and sanctified ear of corn, the material given by the gods and prepared by man, as the means whereby generated life is sustained, and finally, both these are regarded as the resting place or couch of the Father and Mother of corn-crops or seed; the *yá-po-to* being the male, the *mi-k'iap-pan-ne,* the female.

EARS SELECTED WHILE GROWING.

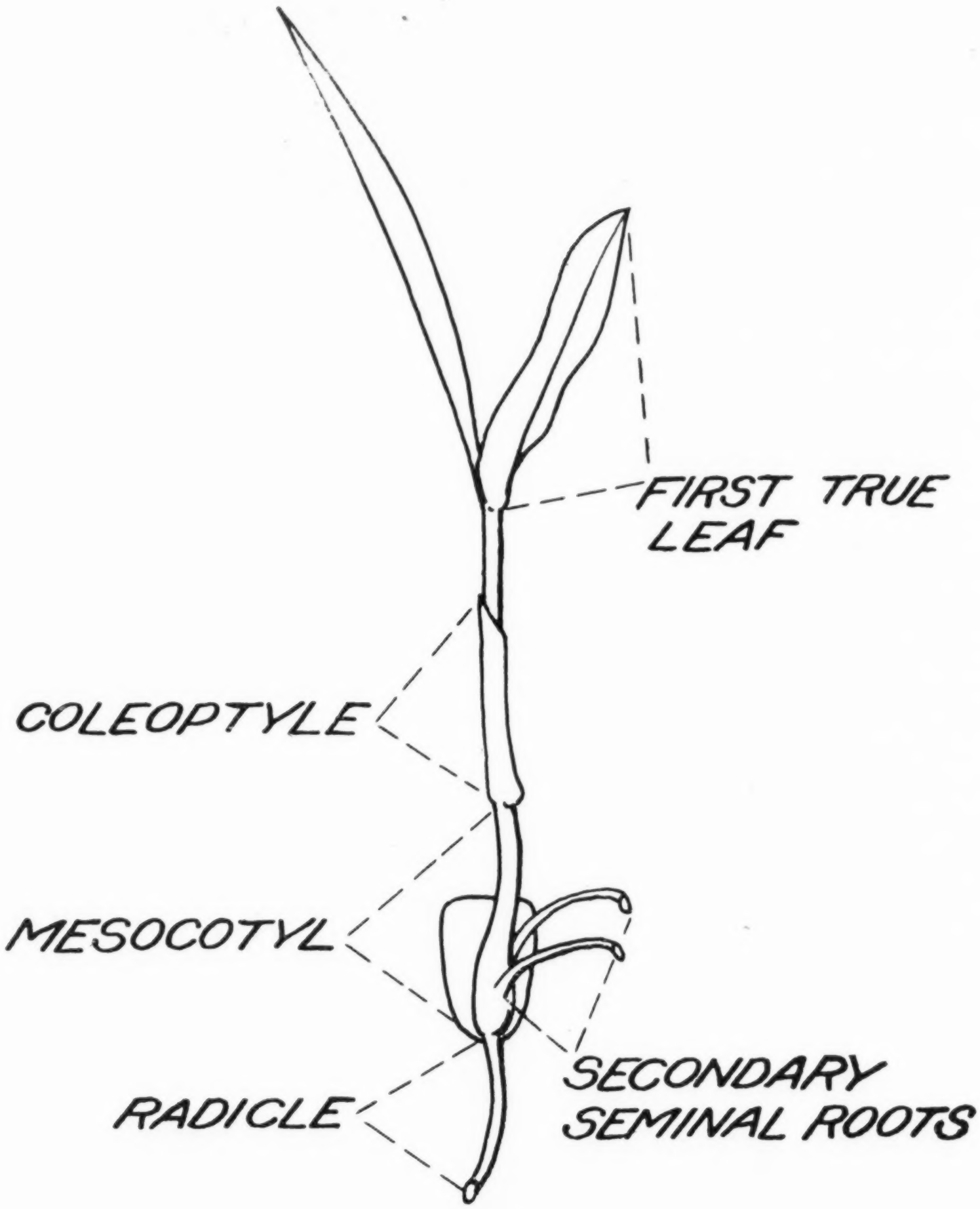
"In a field of growing maize the owner selects such hills as give promise of speediest maturity. These receive his special care. No sooner have a few ears ripened on them than he picks the most perfect, as well as a bunch of soot from some neighboring stalk, and tenderly carries them home in his arms. Arrived at the entrance-way of his house he calls to the women within:

"'We come!'

"'Ah! How come ye?' say they.

"'Together, happily,' he replies.

"'Then enter ye!' calls out the chorus of women's voices, whereupon the man goes slowly in. One of the women beckons his attention to the 'sitting place,' which, in this instance, is a decorated basket-tray in the center of the room. Thither he proceeds and



THE PARTS OF A SEEDLING MAIZE PLANT

This diagram will furnish the non-botanical reader with the names needed to understand the story of Pueblo Indian maize breeding. (Fig. 5.)

places, one by one, the ears of corn in the tray—using care that they shall all point eastward—and lays the bunch of soot over them. The women of the house flock to the mantel whereon stands the family bowl of prayer-meal, each taking a pinch of the sacred substance, while one of their number, the 'corn-matron,' hastens away to the granary, and carefully lifting the *ya'-po-to* and *mi-k'iap-pan-ne*, brings them forth. As she nears the tray, she says, across the objects in her hands (addressing the new corn), 'My children, how be ye these many days?' Then the new corn is supposed to reply through the voices of the other women, now gathered near, 'Happily, our old ones, happily!' With this the corn matron deposits her burden on the new bunch of soot, and all present say little prayers significant of the occasion and setting forth their wishes for 'age of life, happy fortune and the health of strength born of the food of maize.' This ceremonial is called the 'Meeting of the Children,' and is performed in commemoration of the return of the lost corn maidens under the guidance of *Pai-a-tu-ma*, and their welcome by the Seed-Priests of ancient Zuni.

"With the closing of the prayers, the right hand of each worshipper is passed gently over the tray—while scattering prayer-meal—and breathed from. The corn-matron then returns to the granary, bearing both the old corn and the new. She replaces the old bunch of soot with the new, laying the former away with the fresh ears of corn, and returning the *ya'-po-to* and *mi-k'iap-pan-ne* to their resting place.

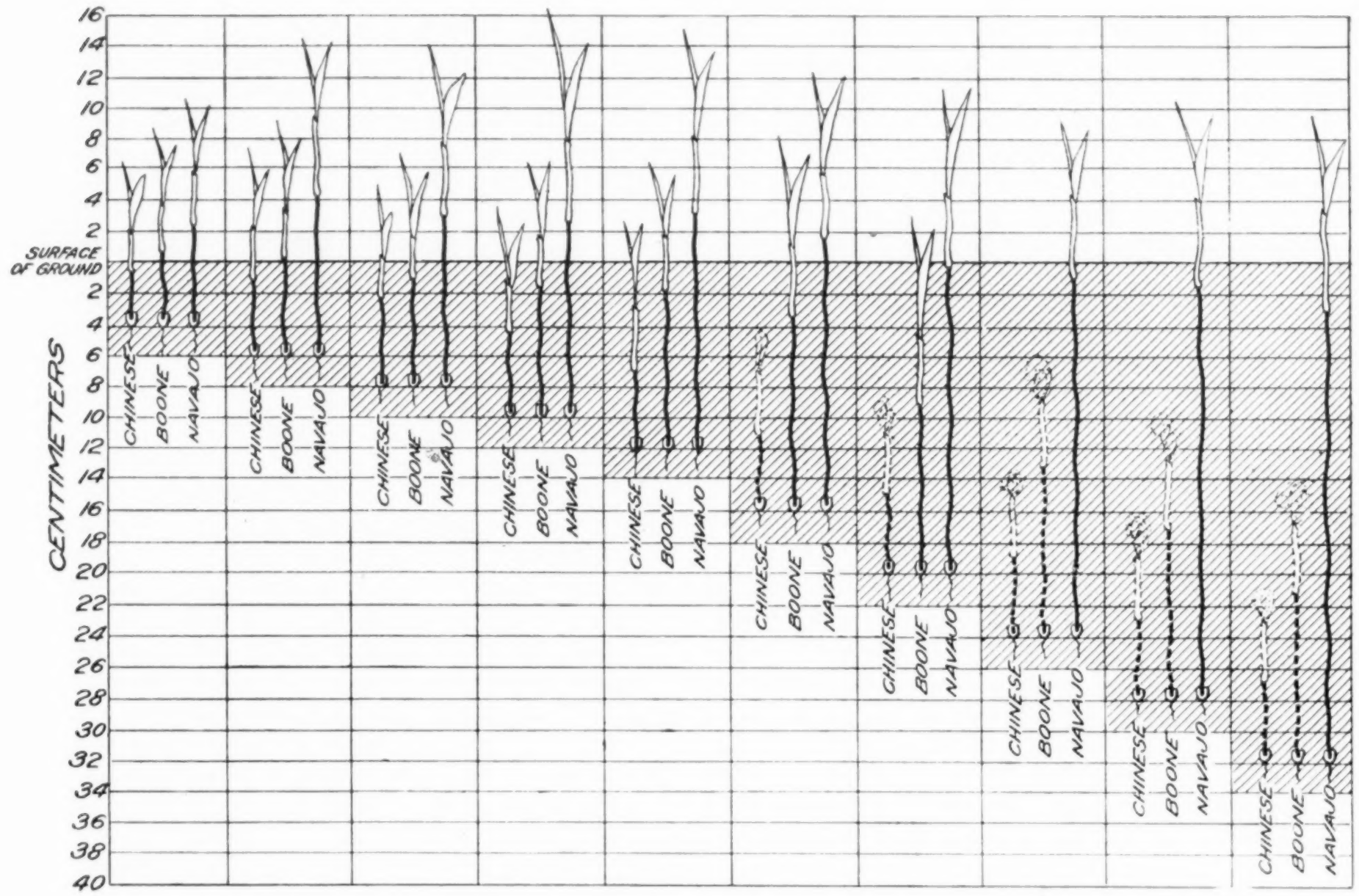
EARS CAREFULLY SORTED.

"When all the harvest has been gathered, dried, sorted and corded up, around and over the 'Father and Mother' in the corn-room, the ceremonial interrupted at the beginning is resumed. While the corn is being classified as to color and grade, the finest ears of each kind are selected and laid aside. These, and the ears of 'new corn' are together laid along the outer edge of the corn-pile. Next morning the corn-matron takes a basket tray—perhaps the same one used before, or at least one like it—and goes to the door of the corn-room. Here she slips off her left moccasin, then enters. As she passes the threshold she looks around as though she were about to address a group of waiting friends and exclaims:

"'My mothers and children, how be ye, and how have you come unto the morning?' and after a moment herself replies: 'Happily!'

"Reverently, for she is in the presence of the conscious and the benign—so it seems to her—she approaches the cord of corn and with her left hand takes of the selected ears along the top, an ear for each finger (that is, four), then with the right hand an equal number, placing them in the tray. She brings these forth and assisted by the male head of the household, shells them with such care that not a kernel is lost. Dust from the old bunch of soot is scattered over the shelled corn, and a curious sacred pigment is prepared, in an earthen ladle, of yellow paint and a kernel of salt, from the mountain near the lake of the dead, and the salt lake in the South. To these ingredients are added two or three kinds of little yellow flowers, the principal variety being precious in the eyes of the Zuni, as that

Seedling of Hopi maize planted eight inches underground. The first permanent roots can be seen sticking out seven and one-half inches above the seed. (Fig. 6.)



SUPERIORITY OF NAVAJO MAIZE FOR DEEP PLANTING

Test plantings of the Navajo dry-land maize, and Chinese and Boone County White, were made in a box at the depths shown in the diagram. The Navajo surpassed its competitors in growth at all depths; but from the lower levels it was the only one to emerge, due to its extraordinary adaptation for such growth, through the elongation of its mesocotyl. The diagram shows that at intermediate depths the Chinese and Boone varieties could not force their coleoptyles to the surface, and were obliged to make the last few centimeters of the distance by the aid of the true leaves, which in general are ill-adapted to pushing through solid earth. (Fig. 7.)

which was left over of the seed stores of the gods. All this is mixed with pollen and water, and the whole tray of kernels is thoroughly sprinkled and anointed by stirring. The corn grains thus treated are bright-yellow in color and pleasantly odoriferous. All this is done that the 'seed' may have the power of reproduction, rapid growth and strength, and that it may bear fruit possessed of the properties of food, which fruit shall mature with the season when thrive most and bloom the little yellow flowers,—early autumn.

SUCCESSFUL SEED SELECTION.

"We are at first surprised when we learn that to a remarkable degree the corn thus treated has vigor and the quality of ripening early; but our wonder may be lessened when we reflect that these seeds are the most perfect of the whole harvest, selected mostly from among those ears which soonest reach maturity. Still, with the Zuni all these things are living testaments of faith, proving the infallibility of his theory of Medicine or Fetichism and of his practice of religion."[1]

Mr. Cushing lived with the Zunis for a number of years and became a member of the tribe. He succeeded to a remarkable degree in attaining the Indian point of view, but appreciation of the Indians did not lessen his zeal for accuracy. This series of articles written in a charming literary style tells not only what the Zunis eat and how they secure their food, but gives a tantalizing glimpse of the character and personality of the Zuni.

In other articles of the same series the cultural methods of the Zunis are described. Though mixed with super-

[1]"Zuni Breadstuff," V, Frank H. Cushing, The Millstone, Vol. IX, Nov. 5, 1884.

stition, the methods employed are seen to be admirably adapted to supply fertility to the soil and to conserve moisture, enabling these Indians to produce maize under conditions that prohibit the growing of this crop by the methods ordinarily employed by whites.

The many incidental references to peculiar agricultural practices in Mr. Cushing's articles suggest that careful study of the agricultural practices of the different Indian tribes might disclose many facts of economic importance to agriculture. The results described in the present paper show one such fact: that we must thank the Indian for calling our attention to deep planting as a factor in drought resistance and for having developed a type of maize with peculiar characteristics that permit the utilization of this factor to an extraordinary extent.[2]

VALUABLE LORE NEGLECTED.

The development of maize as a cultivated plant must have involved a long series of unconscious experiments which resulted in important agricultural discoveries. That the results of these experiments are clothed in the language of myths and legends should not obscure the fact that in many instances they reveal sound agricultural principles. The study of this primitive agricultural lore has too long been left to the ethnologist. We have accepted the Indian's gift of maize but have hastened away without stopping to learn its full value or how best to utilize it.

Had we taken the trouble to learn and appreciate the Indian's discrimination in the choice of varieties, the differences in flavor and adaptability to different methods of cooking, we would not have assumed this valuable human food to be useful chiefly for the nourishment of our domestic animals.

Indians of the Southwest have preserved from pre-Columbian times a type of maize able to produce fair crops in regions where the better-known varieties of the East fail for lack of sufficient water. An important factor in the drought resistance of this type of corn is its ability to force the growing shoot of the seedling to the surface of the soil when planted at a depth of a foot or more. At such depths less specialized varieties die before reaching the surface.

The literature of corn contains reports of many experiments conducted to determine the proper depth of planting, but the results are confusing and contradictory. It has generally been realized that the optimum depth is influenced by differences in soil and climate, but that the proper depth might vary with different varieties seems not to have been appreciated. The varying behavior of types when planted at different depths is additional proof that it is unsafe and unscientific to generalize with respect to cultural factors without taking type, varietal and even individual differences into account.

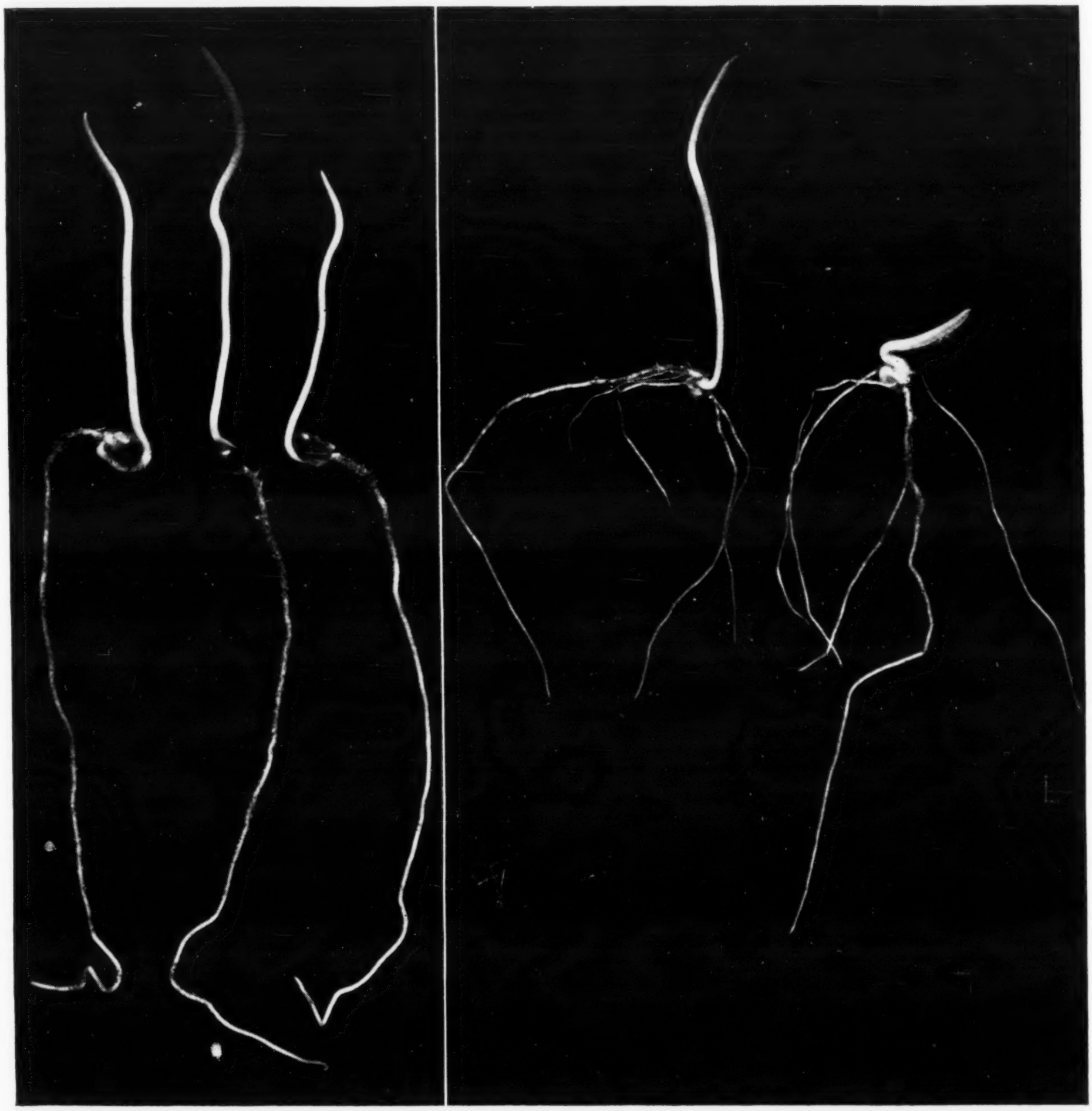
The primary root or radicle which is the first organ to emerge from the germinating seed is soon followed by the shoot or plumule. Enclosing the shoot is the cotyledonary sheath or coleoptyle, a tubular organ which is closed and pointed at the upper end. Between the base of the coleoptyle and the seed, the axis is somewhat elongated (see Fig. 5). With seeds germinated in the laboratory this elongation is so slight that it might easily be overlooked. Nevertheless, this small organ has not escaped the notice of morphologists and its nature has been the subject of much discussion. It has been called variously hypocotyl, mesocotyl and epicotyl. By some it is held to be an internode, by others merely an elongated node.

HOW THE SHOOT REACHES DAYLIGHT.

When a grain of corn germinates in the ground this usually insignificant organ is of vital importance to the life of the plant, for it is through the elongation of this mesocotyl that the shoot is enabled to reach the surface.

So long as a maize seedling remains below ground away from light, the mesocotyl will continue to elongate, until it reaches a maximum length that

[2]The description of the drought resisting adaptations of this type of maize has been published in The Journal of Agricultural Research, Vol. 1, No. 4, Dept. of Agriculture, Washington, D. C., January 10, 1914, where the subject is treated in a somewhat more botanical way.



SPECIALIZATION IN HOPI SEEDLINGS

The varieties bred by the Indians of the southwest have but one seminal root, as shown in the three seedlings at the left (fig. 8); and they are able to throw their entire energy into the prolongation of this single radicle, so that they can force it down into moister ground, as the moisture recedes during periods of drought. Ordinary varieties like the Chinese, two seedlings of which are shown at the right (fig. 9), throw out several seminal roots and are obliged to divide their energy; thus they can not reach to the depths which the single radicle of the Hopi variety attains. In the struggle for existence during drought, the Hopi variety thus possesses a decided advantage.

varies in different varieties of maize. As the mesocotyl elongates, the coleoptyle with its firm, sharp point is pushed upward through the soil. As soon as the coleoptyle emerges from the soil the elongation of the mesocotyl ceases and elongation of the internode bearing the first true leaf begins, forcing open the coleoptyle.

If the seed is planted so deep that the maximum elongation of the mesocotyl fails to bring the coleoptyle to the surface the task of penetrating the soil and reaching light devolves upon the first true leaves. In comparison with the sharp coleoptyle, these leaves are but poorly adapted for forcing their way through the soil, and if the tip of the coleoptyle stops more than a few centimeters below the surface these leaves usually crumple and never reach the light.

In the varieties of maize commonly grown the mesocotyl can seldom be forced to a length greater than four inches, while in the Hopi and Navajo varieties this usually minute organ may reach the relatively enormous length of 10 or even 12 inches, thus making it possible for these Indians to plant their maize deep in the ground where the soil is moist and germination is assured.

The mesocotyl is a beautiful contrivance for removing the young seedling from the seed and planting it at the proper depth from the surface. The true base of the plant is the base of the coleoptyle, the point from which the permanent roots arise. Since elongation of the mesocotyl ceases when the tip of the coleoptyle reaches the light, the length of the coleoptyle determines the depth at which the first permanent roots develop.

Figure 6 shows a seedling of Hopi maize as it developed when planted eight inches below the surface of the ground. The first permanent roots can be seen developing at the base of the coleoptyle 7½ inches above the seed.

GERMINATION OF NAVAJO MAIZE.

In the fall of 1912, W. T. Swingle and K. F. Kellerman of the Bureau of Plant Industry visited the region about Shiprock, N. M., in the Navajo reservation, and secured specimen ears of the maize grown by the Navajos. This collection was kindly placed at the disposal of the writer. Additional seed was later secured through the courtesy of Wm. T. Shelton, agent at Shiprock.

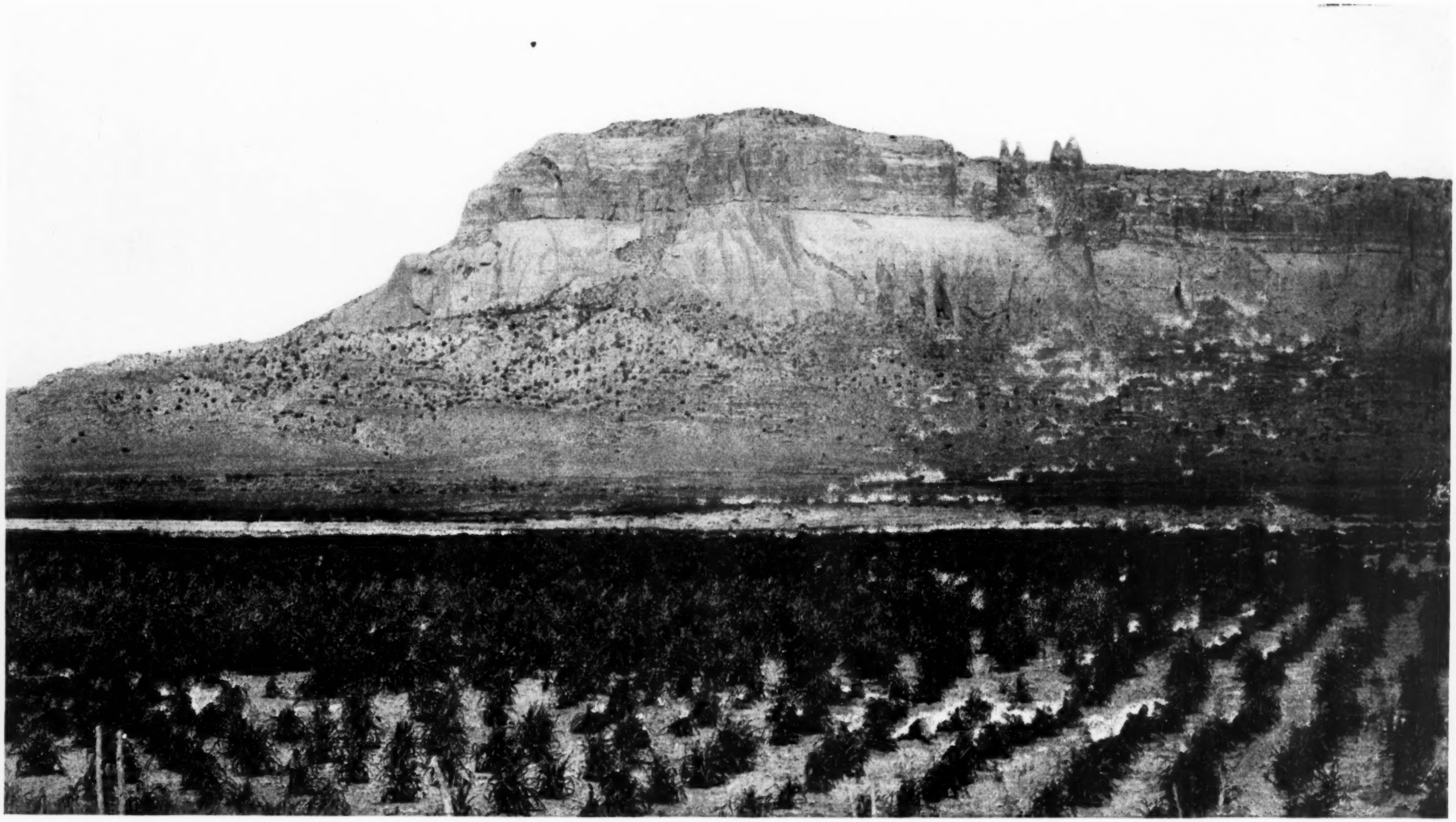
It has been frequently stated that the Navajos, like their neighbors the Hopi and Zunis, plant maize at unusual depths, 6, 12 and even 18 inches having been reported. Since planting at such depths was known to be impracticable with other varieties, an experiment was planned to test the ability of the Navajo maize in piercing the soil. A box, 70 cm. by 33 cm. and 34 cm. deep was sunk in the ground. A quantity of sandy loam soil sufficient to fill the box was slightly moistened and carefully sifted. At one end the box was filled to within one cm. of the top, the soil sloping in a straight line to within one cm. of the bottom at the other end.

Five seeds each of Navajo, Boone County White, and Chinese maize were placed in a row transverse to the inclined surface of the soil, two cm. from the top of the box.

A similar row was planted at four cm. from the top, and so on at the following depths: 6, 8, 10, 12, 16, 20, 24, 28 and 32 cm. The box was then filled with the soil and struck off level with the top. The seeds germinated promptly, and when the most advanced seedling had reached a total height of about 60 cm. the plants which appeared above the surface were dug up and the mesocotyl and coleoptyle were measured (see Fig. 7).

Twelve cm. was the greatest depth from which Chinese seedlings appeared at the surface. Boone seedlings appeared from all depths up to 20 cm. while Navajo plants appeared from all plantings to the very deepest, 32 cm.

There were numerous instances where the combined length of the mesocotyl and coleoptyle was less than the depth at which the seed was planted. This, of course, means that the upper layers of the soil were penetrated by the true leaves. The maximum depth of soil thus penetrated by the true leaves of the plants of the Chinese variety was five cm. One Boone plant forced its leaves



ZUNI PLANTATION OF MAIZE IN ARIZONA

The soil is sandy and, except during rains, is quite dry on the surface. The seeds are planted at five to seven inches below ground, where there is sufficient moisture to germinate them; and as the ground dries out to lower levels, they thrust their single seminal roots farther down, so that they remain green and vigorous while plantings of ordinary varieties of maize under similar conditions dry up and perish. This photograph was made near Black Rock, Arizona. (Fig. 10.)

through eight cm. of soil. In all of the Navajo plants the coleoptyle reached the surface.

The extent to which the Chinese and Boone seedlings were able to penetrate the soil by means of the true leaves was doubtless much greater in the carefully prepared soil of the experiment than would be the case under field conditions where any slightly compacted lump of soil would deflect the tender leaves and cause them to crumple. On the other hand, many seedlings failed to come up where there was less than two cm. between the top of the coleoptyle and the surface of the ground. The results clearly show that the coleoptyle is the proper organ for penetrating the soil and where this office devolves upon the leaves, germination is uncertain.

It has been observed in many field plantings that the spatulate first leaf, formerly called the cotyledon, is the first evidence of the germinating plant. When this occurs in any considerable proportion of the plants, it is safe to assume that the seed has been planted too deep for the best results.

In examining these experimental plants it was observed that the root system of the Navajo variety differed from that of the other varieties. The roots of the Navajo seedlings extended to a greater depth, but there was only a single root arising from each seed, while in the Chinese and Boone seedlings the roots were shorter and more numerous. Further experiments with Hopi and Zuni varieties showed them to be like the Navajo variety in producing but a single root from the seed.

The roots of maize are of two kinds, those that rise from the embryo or seed, called seminal roots, and those produced from the nodes of the plant. Of the latter class, those that arise from the nodes above the ground are often called brace roots or aerial roots. In the varieties commonly grown in the United States there are, in addition to the primary root or radicle, from two to six additional roots that arise from the base of the cotyledon. These secondary seminal roots, though appearing somewhat later, usually equal or exceed the radicle in size. In the Pueblo varieties of maize these secondary seminal roots have been absent in all seedlings thus far examined, the radicle being the only root arising from the seed (see Figures 8 and 9).

FIELD STUDIES OF PUEBLO MAIZE.

In September, 1913, opportunity was afforded for a short visit to the Zuni, Navajo and Hopi Indian reservations of Arizona and New Mexico. It was thus possible to form some idea of the agricultural significance of the peculiarities and habits of germination of this type of maize.

The value of deep planting made possible by the greatly elongated mesocotyl was obvious. In the localities selected by the Indians for planting maize the soil is sandy and in the absence of spring rains the surface layers are, of course, very dry. The seed, to germinate at all, must be planted deep enough to be in contact with the moist soil. In Navajo fields near Tohachi, N. M., plants were dug up and the remains of seeds were found at depths ranging from five to seven inches below the surface. Similar depths were found in a Zuni field near Black Rock, Arizona (see Figure 10.) In a Hopi field at Polacca, Arizona, near the first mesa, where the conditions are extreme, the seed had been planted at 10 inches from the surface. It thus appears that there is no fixed depth for planting, the custom being to plant deep enough to place the seed in moist soil. If the seed were planted at ordinary depths, germination might be delayed until the latter part of June or the first of July, at which time the rains usually occur, or if the seeds germinated as a result of one of the occasional showers occurring in May, the plants would die from subsequent dessication.

Like the long mesocotyl, the simple radicle of the Pueblo maize may be looked upon as an adaptation to the extreme conditions that exist where this type is grown. For six or eight weeks after planting no rain can reasonably be expected and during this time the moisture is constantly receding from the surface. By concentrating the energy of the seedling into a single root the latter is forced to greater depths and consequently kept in soil that is more

HOW THE HOPI INDIANS GROW MAIZE

Field at the base of the first Hopi mesa, near Polacca, Arizona. The hills are planted about 20 feet apart with 10 to 20 plants in a hill. The soil was apparently pure sand washed down from the mesa by winter rains, and was so dry that not a weed was to be found. In such unfavorable conditions the maize seeds planted at a depth of about 10 inches (25 cm.) had sent down their single, vigorous radicles or seminal roots to a depth of 14 or 15 inches more, so they were drawing moisture from a depth of at least two feet below the surface. No variety of corn cultivated in the eastern United States could possibly survive under such extreme conditions. (Fig. 11)

MAIZE GROWING UNDER DIFFICULTIES

With most of the improved varieties of maize, the plant's chief concern seems to be to produce leaves and stalk. The ear is the last thing to receive its attention; in consequence, the ear is the first part of the plant to suffer under extreme drought or other unfavorable conditions. The habit of the Pueblo varieties is just the reverse; they seem determined to produce seed, even if they accomplish little else in life. A plant of this kind is shown here, where the single ear is more than one-half the height of the entire plant. (Fig. 12.)

moist than would be the case where a number of seminal roots developed.

Thus under ordinary conditions where moisture is distributed through the entire seed bed the seminal roots become of little importance as soon as the seedling is established and nodal roots have developed. If a half grown or nearly mature corn plant is carefully dug up, the seminal roots and traces of the seed can still be found but they are usually dry and shrunken and are obviously of little use to the plant. This was also the condition found in Navajo and Zuni maize fields, though the seminal roots were more strongly developed than in the eastern varieties. But, in the more extreme conditions existing in the fields near the Hopi villages, where, as stated, the seeds were planted deeper, it was found that the seminal roots were relatively much larger and were still alive and fresh, making it apparent that they retain their function of supplying moisture, and are able to play an important part during the entire life of the plant.

HOW THE MAIZE IS GROWN.

In one field at the base of the first Hopi Mesa the hills of maize were planted about 20 feet apart with from 10 to 20 plants in a hill (see Figure 11). The soil was apparently pure sand washed down by the winter rains and entirely destitute of vegetation other than the planted maize. An average hill dug up in the field was found to contain 15 plants ranging from 60 to 90 cm. in height. The remains of the seeds were found at 25 cm. from the surface and from each seed there descended a single large seminal root. These seminal roots were traced to a depth of 35 cm. and extended even farther down. They were still fresh and densely covered wi.h fine branches. This mass of 15 seminal roots, while less in volume than the nodal roots arising near the surface, was apparently playing an important part in the support of the plants. The mesocotyls connecting the seminal roots with the plants above, while dry on the outside, were filled with live tissue quite unlike the dry and shrunken mesocotyls found in plants of similar age grown under more favorable conditions.

When planted by the Indian methods, the Hopi and Navajo varieties of maize have been found superior to the more improved eastern varieties for these very dry regions. At the time of our visit there was a small field near Keams Canyon that had been planted by eastern methods. The plants were in rows and thinned to one stalk to the hill. There had evidently been a fair germination but the plants had died without reaching maturity and had produced no seed. At the same time in the nearest Indian fields at Polacca the plants were dark green and maturing a fair crop, though the season was said to have been unusually dry.

Under extreme drought or other unfavorable conditions the persistent tendency of this type of maize to produce seed is very striking. Where any growth is possible it seems to be expended in the production of seed. Many plants were seen where the length of the ear was equal to one-half the height of the entire plant. A plant of this kind is shown in Figure 12. With most of the improved varieties of maize the ear is the first instead of the last part of the plant to suffer when unfavorable conditions are encountered.

Even under irrigation the somewhat larger strains grown by the Navajos have been found to compare very favorably with eastern types. Several acres of Navajo maize were seen at Shiprock, N. M., under irrigation. The fields were very uneven, apparently the result of alkali, but in the better portions the yield was good. The plants were standing about two feet apart in the row, the rows four feet apart, and nearly every plant was bearing from two to four fair sized ears (see Figure 13). The ears from 36 plants representing a number of distinct types were collected. The 36 plants bore in all 94 ears weighing 37.6 lbs., an average of 15.2 oz. per plant. The plants producing these ears averaged only a little over five feet in length.

CONCLUSIONS.

American agriculture is under obligation to the American Indian for having developed the maize plant to a high state of efficiency and for having adapted it to a wide range of environment.

NAVAJO MAIZE GROWN UNDER IRRIGATION

A single plant photographed, with the leaves and husks removed, at Shiprock, New Mexico. Although these Indian types of maize are particularly adapted to dry-farming, their yield under irrigation compares favorably with that of the ordinary commercial varieties. (Fig. 13.)

The importance of the unconscious pioneer agricultural work of the Indian has not been adequately appreciated. Many of the agricultural requirements of maize laboriously ascertained by experiment might have been learned from a study of the agricultural practices of the Indian.

The agricultural Indians of the Southwest have continued, from prehistoric times, to grow maize successfully in regions where drought, and especially the absence of spring rains, make the growing of the common varieties impossible. A study of the varieties grown by the Hopi and other agricultural Indians shows that these varieties possess two special adaptations: (1) A greatly elongated mesocotyl that permits deep planting and (2) the development of a single large radicle that rapidly descends to the moist subsoil and supplies water during the critical seedling stage.

This indigenous type of maize seems to have attracted little attention, perhaps because it has been included in the popular mind with a series of inferior varieties commonly known as "squaw corn." But the Pueblo Indians of Arizona and New Mexico have strains sufficiently productive to compare favorably with improved varieties even when grown under irrigation. The peculiar adaptations of this type definitely indicate its value for the semiarid regions, and warrant experiments to determine the possibility of its utilization.

It is believed that a canvass of the varieties of maize grown by the Indians and a careful study of the agricultural practices of the different tribes will disclose much of interest and value to American agriculture.

The First and Last Child

With a view to throwing light on the question whether the first-born children, or the last-born children in large families, are inferior in vitality to the rest of their fraternity, Dr. Alfred Ploetz of Munich, Germany, compiled the returns from a large number of families of the nobility, and published them in the Archiv für Rassen und Gesellschafts-Biologie (VIII, 761). He does not interpret his figures, but they seem to show very little difference in the viability of children in a family, with regard to their order of birth.

He grouped all the first-born children together, all the second-born children together, and so on, and then found how many of them had died before the fifth year of life. The results, so grouped, are as follows:

Order of Birth	Number of Children Included	Per Cent. That Died
First-born children	614	26.4
Second-born children	539	24.9
Third-born children	455	26.4
Fourth-born children	386	25.6
Fifth-born children	311	26.0
Sixth-born children	249	26.1
Seventh- to ninth-born children	463	26.3
Tenth- to nineteenth-born children	302	34.4
Totals	3319	26.7

A RADISH-CABBAGE HYBRID

Cross Between Two Genera Shows Extraordinary Vigor but Absolute Sterility—Pollen Irregular Both in Size and in Shape—Two Extra Stamens Present in Some of the Flowers.[1]

FLIPPO GRAVATT, *Blacksburg, Va.*

IT IS a general rule with organic forms that whenever their systematic differences are very great, they will not hybridize with each other. A large number of species will hybridize with other species of the same genera, though the product obtained is usually sterile. The great majority of species will not hybridize with other species of the same genus. In regard to crosses between different genera a good many have been reported. Each of these successful crosses represents hundreds of unreported failures, owing to the great difficulty in effecting such a cross. These generic crosses have been effected in various different families, both in the Dicotyledons and in the Monocotyledons.

In the Cruciferae, mention was found of one generic cross, that between the garden radish, *Raphanus sativus*, and the garden cabbage, *Brassica oleracea*. This cross was made by Segeret, a German, many years ago, although there seems to be doubt about it in the mind of Fockle, who reports Segeret's work.

The chief distinction between the genera Raphanus and Brassica are that the pod of the former is one celled or with spongy transverse partitions, while that of Brassica is longitudinally two celled and dehiscent. Between the two species there are a number of differences, but these will be noted later. The radish and the cabbage have both been developed in cultivation for hundreds of years.

In the greenhouse during 1910 a large number of flowers of three different varieties of radish were emasculated and bagged. Two days later, when most of the stigmas were in receptive condition, they were pollinated with pollen from a cabbage plant which was a first generation hybrid between the varieties "Volga Russian" and "Curled Savoy." Perhaps the fact that the cabbage plant was a hybrid had something to do with the success of this generic cross. The bags were left over the pollinated flowers for two weeks. At the end of that time all had dropped off except two small pods of the variety "Long Scarlet Short Top." A large number of cabbage flowers were emasculated and pollinated with different varieties of radish, but no fruit set.

In September, 1910, the contents of these two pods, consisting of several small, shriveled seeds, were planted. Only one came up and from the first it could be seen that it was a cross. It was very vigorous and grew rapidly, finally being transplanted from a 20 inch pot to a central bed.

CHARACTER OF THE HYBRID.

The hybrid produced a great abundance of large leaves. In size and shape they are nearer to the cabbage, but are much larger than those of either parent. The largest leaf of the cross was five feet nine inches from tip to point of attachment, and one foot seven inches broad. The leaf was measured at the time the plant started blooming.

In color the hybrid leaf is a mean between the light green of the radish and the dark or blue green of the cabbage. In taste it is more like the cabbage, but one can still detect some of the radish pungency. The radish leaf is pubescent with stiff hairs, while the cabbage leaf is glabrous. Leaves of the cross are nearly glabrous. The

[1]This work was carried on during post-graduate studies at Virginia Polytechnic Institute under Prof. H. L. Price and Prof. E. A. Smyth.

RADISH-CABBAGE HYBRID WHILE YOUNG

The growth habit of both parents is similar to that here shown, when they are young. Later the cabbage "heads up" and the radish does not; the hybrid followed the radish in this respect, but did not develop any tuberous root such as the radish produces. (Fig. 14.)

cabbage leaf is much thicker than that of the radish: leaves of the cross are intermediate between the two.

It would seem likely that the hybrid would inherit some tendency towards tuberous root formation from its radish parent, but such did not seem to be the case. The hybrid does not even show a well developed main tap root, but divides into numerous branches at a short distance below the surface.

The stem of this hybrid is several times larger than the combined stems of the two parents. When the hybrid reached the size shown in figure 15, the circumference of the stem was 13½ inches, measured at a distance of one foot from the ground. The stem holds its size for some distance from the root. The lower part or about the first two feet of the stem is very thickly beset with leaves, thus resembling the cabbage in habit. These leaves drop off on account of shade from above, leaving large and prominent scars. Starting from the surface of the ground, the major portion of the stem is a purplish red color just the same as that of the radish, but this purplish red color covers the stem of the hybrid much more thoroughly and extends further up than it does on the radish parent.

GROWTH HABIT.

When still young the general growth habit of the radish and of the cabbage is quite similar. It is a spreading, diffuse growth. It is not long, however, before the cabbage begins to head up and packs most of its leaves into a solid, bud-like formation. Some time after this head reaches maturity, the bud begins growing in the center, by its development breaks the head open, and then grows upward rapidly, being nourished on the food stored in the thick leaves.

AN EXAMPLE OF HYBRID VIGOR

Hybrid forms usually excel either of their parents in vigor, and agriculturists have long taken advantage of this fact, in the production of both plants and animals. It is seldom, however, that so much extra energy is shown as by this cross between radish and cabbage, neither of which ordinarily reaches great size. The cross continued growing for five months after the above photograph was taken, and at the time it was killed by bacterial rot, it had gone through the ventilator of the greenhouse and was traveling down the roof on both sides. (Fig. 15.)

The radish differs from the cabbage in that it retains its open diffuse habit of growth. Instead of forming a solid head of leaves, it develops a tuberous root and in this stores its surplus food. Then when the radish reaches maturity, a bloom stalk is sent up, being nourished chiefly on stored food from the root.

The hybrid has an open, diffuse growth habit. During the stage in which the radish develops its root and the cabbage its head, the hybrid continues to develop numerous large leaves. These leaves are so thick that a large number of the lower ones die and drop off, due to lack of light.

At first there is a single elongated shoot, but sometime before blooming, numerous side branches start out. In figure 14, the side branches are just starting. The main shoot develops into a bloom stalk just as in the case of the

parents. This one is shortly followed by others from the side shoots. These bloom shoots attain a much greater length than those of either of the parents. The side shoots make a growth of several feet before any buds are developed. Figure 15 shows the enormous growth of this hybrid. It continued to grow for nearly five months after this photograph was taken, finally being killed by a bacterial rot of the root and stem. At the time of its death the hybrid had grown out through the ventilator and for a short way down the roof of the greenhouse on both sides.

FLOWERS.

The pediceled flowers of this hybrid are borne on a greatly elongated rachis, which in some cases attains the length of three feet. The flowers of the parents are borne in the same way, though the flowering axis or rachis does not grow to such a length as with the cross. Perhaps the greater length of the rachis was due to the fact that no pods set and therefore all the food went to the development of the flowers.

The buds of the radish are obovate in shape, while those of the cabbage are oblong-elliptical and much larger and longer. The buds of the cross are a mean between those of the two parents in shape and size. Near the top of the bud of the radish, there are several prominent hairs growing out from the sepals. The cabbage and the radish-cabbage cross do not have these hairs.

The cross has four petals, intermediate in size between the two parents. The radish parent was dominant in regard to color of the petals, the background color being white with a purplish tinge and veins. There was no sign of the rich yellow color of the petals of the cabbage parent.

The radish and cabbage flowers each have six stamens. Most of the flowers of the cross had six stamens but a good many had two extra well developed stamens, making eight. There were about 15% of the flowers which showed this variation. These two extra stamens bring up some interesting questions which will be discussed in another article.

It was noticed that the pollen from this cross was not powdery and light as that of the radish and cabbage, but stuck together and had a tendency to ball up. There was often difficulty in spread ng the pollen out on the stigma. On examination it was found that the pollen from the radish and that from the cabbage were very regular in size and shape, while that of the hybrid was very irregular in both respects. Attempts to germinate the pollen from the hybrid in various solutions all failed.

Most of the ovaries of the hybrid appear to be two-celled like those of the cabbage parent. One slide of a hybrid pistil showed sections of an ovary with three cells.

STERILITY OF THE HYBRID.

About crosses between species De Vries says: "Whenever their systematic differences are too great, the crosses will be infertile, even with the pollen of their parents. Repeated crosses are impossible and no practical results can be obtained." Generic crosses are nearly always sterile. Most of them do not even produce flowers and if they do, the flowers are usually aborted in some way.

In March, 1911, this hybrid started blooming in great profusion. Nearly every day during March, April and May, pollen from different varieties of radish and cabbage, including the parents, and from cauliflower, collards, Brussels sprouts and their crosses, was tried on the flowers of the radish-cabbage hybrid, but nothing resulted. The hybrid was also sterile to its own pollen. Flowers of the radish, cabbage and various Brassica crosses were emasculated, bagged and pollinated with the hybrid pollen, without results. The same process of pollination was gone through in the winter of 1912 with a root cutting of the hybrid and again resulted in failure.

ORIGIN OF THE BANANA

One of Earliest Crops Cultivated by Man—Perhaps Valued at First Only for its Roots—Doubt as to Time of its Introduction to America—Prehistoric and Allied Forms—Irregularities of its Behavior in Cultivation.

THE EDITOR.

THERE seems little reason to doubt that the banana was one of the first foods of man, and that it was one of the first plants cultivated.

"Wild bananas and their botanical relatives," says O. F. Cook,[1] "are natives of the rocky slopes of mountainous regions of the moist tropics, where shrubs and trees prevent the growth of ordinary herbaceous vegetation." It is probably in a similar region that the first appearance of Man is to be looked for. "Everything leads one to believe," as Beccari[2] says, "that the principal cultivated fruits originated in the region where man first acquired a high grade of civilization." Primordial man of the tropics was undoubtedly an agriculturist rather than a live-stock breeder. He lived on the resources most readily furnished him by nature, and among these, few would be more readily available than the banana. It is permissible, then, to suppose that the banana was one of the first fruits which attracted his attention; that he soon brought it under cultivation, and that he at once began to submit it to that long process of improvement which has continued for some hundreds of thousands, perhaps, of years, and is more active today than ever before.

If Man appeared in the Indo-Malayan region, as is widely believed at present, it seems natural to seek for the origin of the banana in the same region; and such a location for it is accepted by most botanists. This primitive banana probably did not differ widely from the wild bananas found today in many parts of the tropics, although none of the latter can be confidently pointed out as representing the ancestral type. Beccari, indeed, considers that all the wild forms known today are merely cultivated forms which have escaped from cultivation at some time in the past. He found in Borneo four new species which grew only in regions deforested by man Whence were they brought? he asked himself, and was obliged to conclude, after a survey of the whole problem, that probably each region develops its own well characterized species of Musa —a conclusion which finds support in the fact that no species yet known has a very wide geographical distribution. At present the genus seems to be dependent on man for its possibilities of development: it can not make its way in the primitive forest, he concludes. It is one of the many crops which have been so changed by man to meet his own needs that they are no longer able to hold their own in the free competition of nature.

ROOTS AND HEART EATEN.

The original form of banana must have been of little value as a fruit. Cook has therefore concluded that it was first a root crop, the roots even yet being used by the natives of some regions, while the tender heart was doubtless also an article of food, as it is today in Abyssinia. Cultivated for its roots, the banana began to produce better fruits, by chance, or as a result of asexual propagation, and at a very early day must have become more prized for the latter than for the former.

"The wild varieties are almost wholly seeds," Beccari observes, "but what pulp exists is sweet and agreeable. It therefore only requires some agent to

[1] Annual Report Smithsonian Inst., p. 481, Washington, D. C., 1903.
[2] Beccari, Odoardo, Nelle Foreste di Borneo, p. 611. Firenze, 1902.

inhibit the growth of seeds and promote that of pulp to produce good bananas. Effective causes are sterility produced by hybridization, and improvement by asexual reproduction." Both of these means may have been used by the prehistoric plant-breeders of the tropics. Cross-pollination between different species would easily take place, and would result in at least partial sterility of the product. These hybrids, asexually propagated either by man or by nature, would retain their sterility, and a "horticultural variety" would be established. Beccari's own idea is that all the bananas of today are, in fact, the results of hybridization of various original wild forms which have now disappeared. This in itself would be sufficient to explain the seedless condition of the fruit of commerce; while the numerous seed-bearing species found wild at present are accounted for by Beccari's hypothesis that they represent the product of one of the normally sterile forms pollinated from some species sufficiently distinct to cause the production of normal seed.

VAGARIES OF POLLINATION.

This hypothesis, although somewhat unusual, is given color by recent work in Jamaica, described by Fawcett.[3] Experiments in pollenizing the ordinary, sterile varieties, at the Hope Gardens, were unsuccessful until pollen from the distinct but equally sterile red banana (var. rubra) was used; the normally seedless commercial bananas then set a full complement of seed. He quotes a similar observation from A. d'Angremond[4]: "Most of the pollen of the Jamaican and Apple bananas is sterile, and only a few of the ovules in those plants have an embryo sac. However, dusting the ovaries of these cultivated fruit plants with pollen of *Musa basjoo* and *M. ornata* [two wild species] was sufficient to produce seeds."[5]

Seeds may be produced in an ordinarily sterile variety as a result of environmental conditions, if there is any basis of fact in the story given to O. W. Barrett[6] by a Porto Rican native, who advised: "Get a stool of bananas growing rapidly in shallow soil by the addition of artificial fertilizers; let one bunch of fruits set; but before that ripens, cut down all but one of the stems in the clump. The remaining shoot, 'thinking it has but one more chance to perpetuate its kind before being killed,' on account of the tremendous shock to the more or less connected stem bases in the clump, at once produces a small bunch of somewhat abnormal fruits, some of which will contain seeds." "As a matter of fact," Barrett adds, "it is a usual thing to find seeds in the commonest of the Philippine bananas, the Saba."

The origin of the present seedless varieties is explained by many writers as a matter of simple selection, rather than of hybridization. The knowledge which we are gradually acquiring of the results of plant-hybridization, however, makes it seem plausible that some cross was the starting point from which the tropical native began his process of selection. The little knowledge we have of the agricultural skill of primitive man gives abundant reason to believe him intelligent enough to propagate choice strains of his staple crops by offshoots. In the banana Nature herself showed him the way: for in addition to seeds, which must always have been the normal method of reproduction, the banana could propagate itself rapidly by suckers —unless the primitive types were very different from those we know today. Around the base of the plant numerous small suckers are thrown up; these, it is believed, finally separate themselves from the parent, by the formation of a layer of abscission-cells, and roll down hill (when the plant is growing on a

[3]Fawcett, William. The Banana. London, 1913.

[4]Ber. Bot. Ges. XXX, 686.

[5]I owe to A. B. Stout, Director of the Laboratories at the New York Botanic Garden, the following reference: "G. Tischler, Archiv. Zellforschung 5:622-670, 1910. Tischler investigated three races of *Musa sapientum* and found that the chromosome numbers were respectively 8, 16 and 24, and that the volume of the nuclei was proportionately 1:2:3. He found irregularities in the development of pollen. Some chromosomes lagged behind and formed extra nuclei. Often eight pollen grains are formed from a single-mother cell. I believe this is all the cytological work that has ever been done on any of the bananas."

[6]Philippine Agric. Review, V, 383, 1912.

CLUSTER OF WILD, SEED-BEARING BANANAS

The fruit is concealed by huge bracts, part of which have been raised to show the "fingers." This was probably the original habit of the plant, although these bracts have disappeared in the cultivated forms, so commonly seen in fruit stores. The banana here photographed (by the Bureau of Agriculture, Philippine Islands) is known as Virgen; it is possibly *Musa glauca*, or perhaps a new species not hitherto described; natives of the Philippines propagate it, but only by seed. (Fig. 16.)

slope) until their progress is arrested by some obstacle; then they take root and reproduce their parent form.

ANTIQUITY OF ITS CULTURE.

To sum up, we find the banana established as an important crop as far back as we can see. Beccari, indeed, does not hesitate to suggest its cultivation in the Pliocene epoch, although there is by no means agreement of paleontologists as to whether Man existed as a distinct species in that epoch. In the Miocene, Beccari recalls, we find a wide variety of strange forms; in the Pliocene, we meet forms similar to those which we know today. "It is only in the Pliocene that we find forms of mammals identical with those of the present. . . . It is possible that it was in that epoch that man, clearly established as a species with the characteristics he now shows, had begun to domesticate plants and animals," and if so, we must certainly put the cultivation of the banana in that epoch: first, perhaps, as a root crop, and then as a fruit crop, when man seized and perpetuated in the plant the variations favorable to his needs, which chance inter-specific hybridization may have offered.

From the Indo-Malayan region, according to the generally received account, man must have carried the banana on his migrations, both eastward to the islands of the Pacific Ocean, and perhaps to America; and westward to India, the Mediterranean region, and finally on to America. The plant is admirably adapted for transportation over long distances, because its suckers can be dried and carried without difficulty in that condition for several months, to take root at once when placed in the deep, rich soil which they love.

Of the eastward travels of the banana from the Indo-Malayan region we have little knowledge, but its westward travels are interestingly shown by its names, with an occasional written record.

PLINY'S DESCRIPTION.

Pliny[7] is commonly held to be the first writer to describe the banana, although his account, at second hand, is inaccurate enough to have caused some doubt whether he was describing the banana or not. "There is another tree in India," he writes, "of still larger size, and still more remarkable for the size and sweetness of its fruits, upon which the sages (Brahmins) of India live. The leaf of this tree resembles, in shape, the wing of a bird, being three cubits in length and two in width. It puts forth its fruit from the bark, a fruit remarkable for the sweetness of its juice, a single one containing sufficient to satisfy four persons.[8] The name of this tree is pala, and of its fruit ariena. They are found in the greatest abundance in the country of the Sydraci, a territory which forms the extreme limit of the expedition of Alexander." The name pala is said still to be found as a vernacular name of the fruit in India, while his remark as to its being the food of the sages has given the specific name to the ordinary cultivated banana — *Musa sapientum*, "the Musa of the wise men."

As to the generic name Musa,[9] we may conjecture that it represents the name by which the fruit was received in India from its more southerly tropical home. It comes to us from the Sanscrit Moca, through the Arabic and Latin; a course that prettily illustrates the gradual dispersal of the fruit itself from India through Persia, Arabia, and Syria to the Mediterranean. The old Persian form, which represented the first transition from the Sanskrit, is not known to us. It was probably

[7]Caius Plinius, Historia Naturalis, XII, 12 (6), Rome, A. D. 67.

[8]This can not be taken too literally; yet Stanley (Darkest Africa, I, 252) mentions specimens of plantains 22 in. long, 2½ in. diameter, nearly 8 in. around.

[9]A number of authorities have given credit to the ridiculous story that the genus was named after Musa, a physician of the Emperor Augustus. This etymology is no better than the one put forth by a certain unnamed Franciscan friar who declared "chiamasi questo gentil frutto Musa, percioche le (nine Grecian) Muse usano tal cibo." As Dottor Nicolo Monardes (Delle Cose che Vengono portate dall' Indie, p. 206. Venetia 1582) justly remarks, "E cosa da muouer le risa." A legend that the banana was the Tree of Knowledge of Good and Evil of the Garden in Eden led to the name of Apple of Paradise or Adam's Fig.

A "HAND" OF WILD BANANAS

Although the seeds are numerous and fully developed, they are much fewer in proportion to the amount of pulp than in the African species shown in the frontispiece. This fruit is from Cavite, Philippine Islands, where it is colloquially known as Alinsanay. Botanically, it is probably an undescribed species. On Beccari's hypothesis, it is to be regarded as a once cultivated form, that escaped from cultivation long ago and has regained fertile seeds through cross-pollination with some distantly related type. Photograph from the Bureau of Agriculture. P. I. (Fig. 17.)

taken from Persia by the Aramaic, whose form for it would have been Moza, and the Arabs borrowed it from the latter language, as Mauz or Muz. It was spelled Musa by the Romans, and one or the other of these two forms—Muz and Musa—was the accepted English name until comparatively recent times.[10] In 1578, for instance, Lyte writes in the Dodoens (VI, 38, 704) "of musa or mose tree. The Mose tree leaves be so great and large that one may easily wrap a childe in them." Sixteenth century writers commonly call the fruit Apples of Paradise or Adam's Fig. The name banana gradually came into use in that century; it is the vernacular name given to the fruit by a tribe in the African Kongo. De Orta mentions it in 1563, while Hartwell (Pigafetta's Congo (1597) in Coll. Travels (1746) II, 553), says, "Other fruits there are, termed Banana, which we verily think to be the Muses of Egypt and Suria."

[10]C. C. Torrey, professor of Semitic languages at Yale University, kindly aided me in tracing the travels of this word.

Thus the fruit, carrying with it the name which may have come all the way from its first station in the Indo-Malayan region, reached the Mediterranean and—after the colonization of those islands—the Canaries. From the Grand Canary it was introduced to the New World in 1516, according to the very definite statement of Captain Gonzalo Fernandez de Oviedo y Valdes,[11] who heard the story "from many people." He ascribes the introduction to Hispaniola (Santo Domingo) to the "reverendo padre fray Thomas de Berlanga, de la Orden de los Predicadores"; "and from here," he continues, "it has spread to the other villages of the island, and to all the other islands populated by Christians, and has been carried to the mainland; and in every region where it has been established, it has yielded excellent results."

INTRODUCTION TO AMERICA.

This circumstantial account has always failed to satisfy a certain number of botanists, whose belief that the banana was found here long before the arrival of Columbus is based partly on tradition, more on the belief that it could never have spread so rapidly in the years following the conquest, as to account for its abundance in the many localities where it is reported by early writers; partly on the large number of distinct varieties to be found in the tropical parts of America, and partly on the finding of leaves resembling those of the banana, in pre-Columbian graves in South America. The first consideration seems to have weighed heavily with von Humboldt, who did not hesitate to declare the fruit a native of America, saying, "It is a constant tradition, in Mexico and on all the mainland, that the platano arton and the Domenico[12] were cultivated there long before Europeans arrived." Most of the botanists who have studied the subject have not considered tradition a sufficient ground for judgment: De Candolle contented himself with a verdict for "a prodigious antiquity of cultivation; in consequence, a primitive existence in Asia and a diffusion synchronous with that of the races of mankind, or even earlier."

QUESTION STILL DISPUTED.

As to the evidence afforded by the exhumation of leaves, those who uphold the Asiatic origin of the banana contend that knowledge that these leaves were really Musa is lacking, and that they were more probably leaves of some such plant as Heliconia, a South American relative. O. F. Cook has brought the case prominently forward during the last few years by championing the theory of American origin, but the majority of writers on the subject are still on the other side.

Whether the Musa, as we know it today, was actually cultivated by the natives of the Spanish Main when Columbus found them, there seems reason to believe that it or a closely related plant existed on this continent several millions of years ago. Researches of paleontologists in North America have resulted in the identification of a genus which has been named Musophyllum, and bears extraordinary resemblance to the bananas, although of course there is not sufficient evidence available to decide the exact degree of relationship. The best known of these finds in the deposits of the Eocene epoch are from the vicinity of the Yellowstone National Park. Leo Lesquereux, who described[13] *Musophyllum complicatum* as a new species in 1873, writes:

"Though the specimens representing this species are very numerous and very large, I could not obtain one showing exactly the size and form of these leaves. They appear either folded around a thick stem, from which they diverge, or on both sides of a thick rachis, extending along it like two wings, two or three centimeters wide on each side. From the fact that large speci-

[11]Oviedo, Hist. Gen. y Nat. de las Indias, Lib. XXX, cap. I, pub. in 1535.

[12]Names given by natives to two of the principal forms of the cultivated Musa. The word platano is Spanish, from the Latin platanus, and is the origin of the English plantain, by which bananas fit only for cooking are generally known. Unnatural as such an etymology may seem, it appears to be a fact that the name is due to some confusion with the oriental plane tree (Latin, platanus), wrongly called sycamore in the western United States.

[13]Annual Rep. U. S. Geol. and Geog. Survey of the Territories, p. 418, Washington, D. C., 1873.

mens are covered by fragments of these leaves crushed and folded upon one another, without any trace of middle nerves or peduncles, the leaves must have been of great size. Their substance is not very thin. The surface is perplace covered with an epidermis which shows the veins are crossed by veinlets at right angles. When the epidermis is destroyed, this character is not observable, it may, therefore, result of a wrinkling of the epidermis. The species is related to *Musa Bilinica* Ett., differing, however, by essential characteristics."

FOSSILS IN YELLOWSTONE PARK.

Fifteen years later F. H. Knowlton[14] collected the same species on the northeast side of Crescent Hill, opposite a small pond, in the Yellowstone Park, and wrote:

"This species was described by Lesquereux from a 'shale over a thin bed of coal, eight miles southeast of Green River Station, Wyoming', in what he at first regarded as the Washaki group, but which he later decided was the true Green River Group. This locality has not since been visited, and in fact can not now be satisfactorily located. It is more than probable, however, that the former determination of the horizon is correct.

"So far as I know, this is the second time this species has ever been found. It is represented by five or six fairly well preserved specimens, which agree perfectly with Lesquereux's descriptions and figures.

"On one of the specimens there are a number of thick stems or stipes. They are longitudinally striate, as described by Lesquereux, and bear only fragments of the leaves preserved. In the specimen figured we have a narrow leaf preserved almost entirely. It is about five centimeters broad and seven centimeters long, as preserved, with perfectly entire margins. In still another specimen the stipe, with portions of lamina attached, is fully 20 cm. long. There is no evidence from these specimens of the leaves having been as broad as described in some of the original specimens, but Lesquereux also speaks of narrow leaved forms."

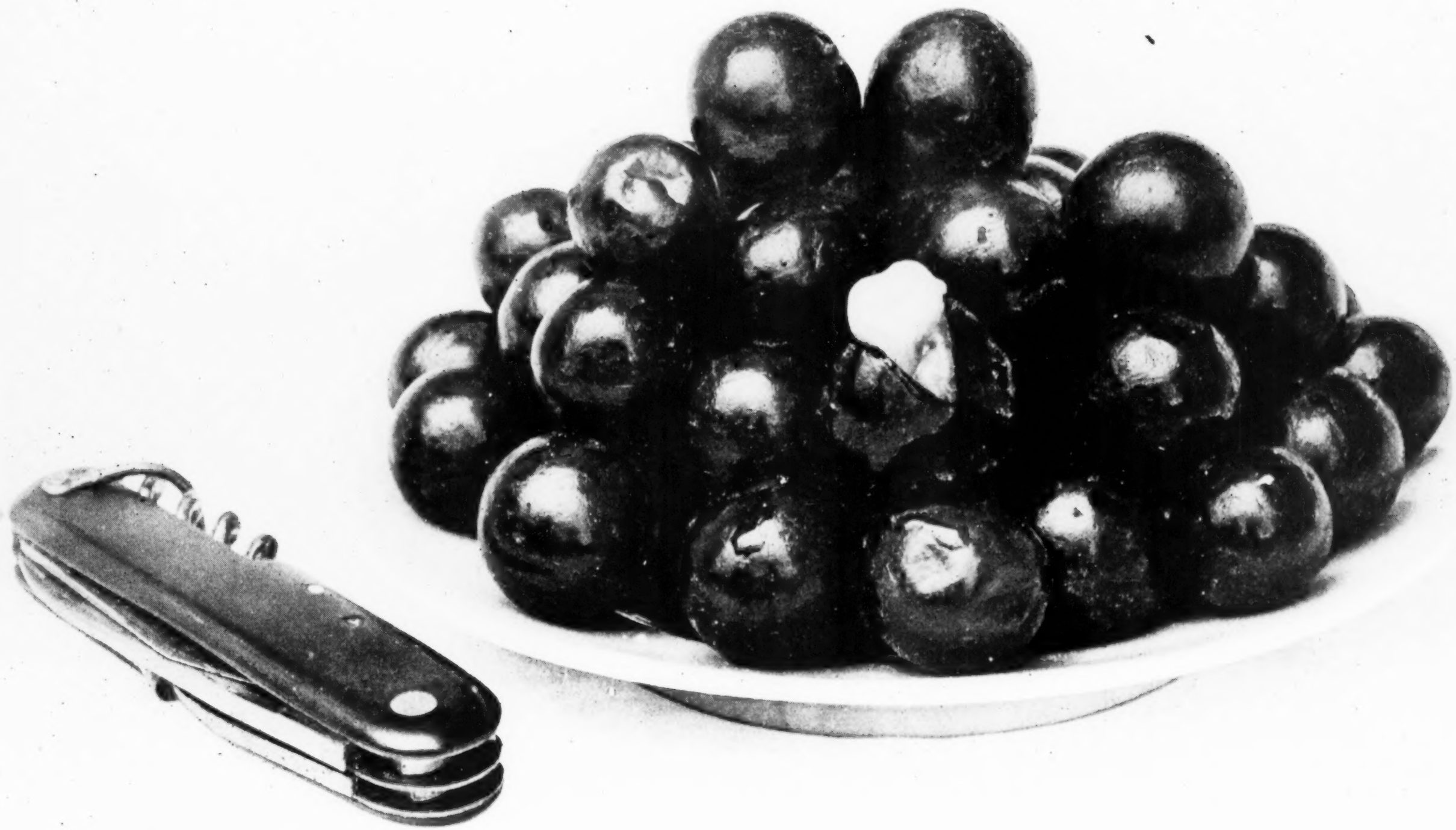
In addition to this remnant of a remote epoch, we still have in America members of the natural order Scitaminaceae, to which the tribe Museae belongs. The most conspicuous is the Traveler's Palm (*Ravenala guianensis*), representing an interesting genus which is known to most people only by the other of its two species, the larger *Ravenala madagascariensis*. The presence of these two closely related species, one confined to the northern part of South America, and the other to the East African island of Madagascar, affords an interesting problem in the geographic distribution of plants,[15] and brings vividly to mind the antiquity of the order. Other members of the same order are the arrowroot, turmeric, cardamom and ginger plants and the strikingly beautiful Bird of Paradise flower, *Strelitzia reginae*, which is often seen in gardens in California and Florida, as well as in its tropical home.

GENUS MUCH CONFUSED.

The present distribution of the banana, then, appears to be no wider than the distribution of its order throughout its history. At present the genus Musa comprises 32 or more distinct species and at least a hundred subspecies, many of them badly confused, and many of them probably representing only the escape of cultivated varieties, or the result of natural hybridization. The Philippines and the Indian archipelago are richest in forms, followed by Ceylon; America is, by comparison, rather poor in them—a fact that has often been adduced to show that the cultivated banana was not known before its introduction by the Spaniards. The genus is divided into two broad sections: Eumusa, with edible fruits, and Physocaulis, with inedible fruits; the former is, for commercial purposes, divided into bananas and plantains, the latter being larger

[14]Monographs of the U. S. Geol. Survey, XXXII, pt. II, p. 686. Washington, 1899. Plate LXXXIII, fig. 1.

[15]Another striking instance is the well known sassafras (*S. officinale*) of the eastern United States. The only other species of its genus is found in the interior of China.



HIGHLY VALUED BUT LITTLE STUDIED

Plate of fruits of the jaboticaba, natural size. Although one of the most highly prized fruits of Central Brazil, they are scarcely known to botanists in other parts of the world, and have been given little study even in their own home. (Frontispiece.)

See "The Jaboticaba," p318.

PLANT-BREEDING IN SWEDEN

Pioneer Work of the Svalöf Institute has Resulted in Revolution in Breeding Methods Throughout the World—The Theory and Practice of Pedigree Cultures—Hybridizing now being Taken Up—New Varieties Put in the Trade

H. Hjalmar Nilsson

Director of the Sveriges Utsädesförening, Svalöf, Sweden.

SINCE its foundation, the Institute of Svalöf has had the satisfaction of drawing attention, not only from the Swedish public, but from foreigners. In the course of time many accounts have also been published in technical journals, concerning its special line of work. Although they are marked by a spirit of admiration and good-will, these judgments of strangers rarely show a correct understanding of what is actually going on here, since that can hardly be known without a knowledge of the motive for the creation of this establishment, its development, and its standing in its own country.

The founding of the station at Svalöf is wholly due to the private initiative of the agriculturists themselves. Its purpose was to furnish new and improved seed to Swedish agriculture. The realization of this purpose and its development have up to the present remained under essentially the same agricultural control, in spite of the fact that the largest part of the necessary funds have been furnished by the public.

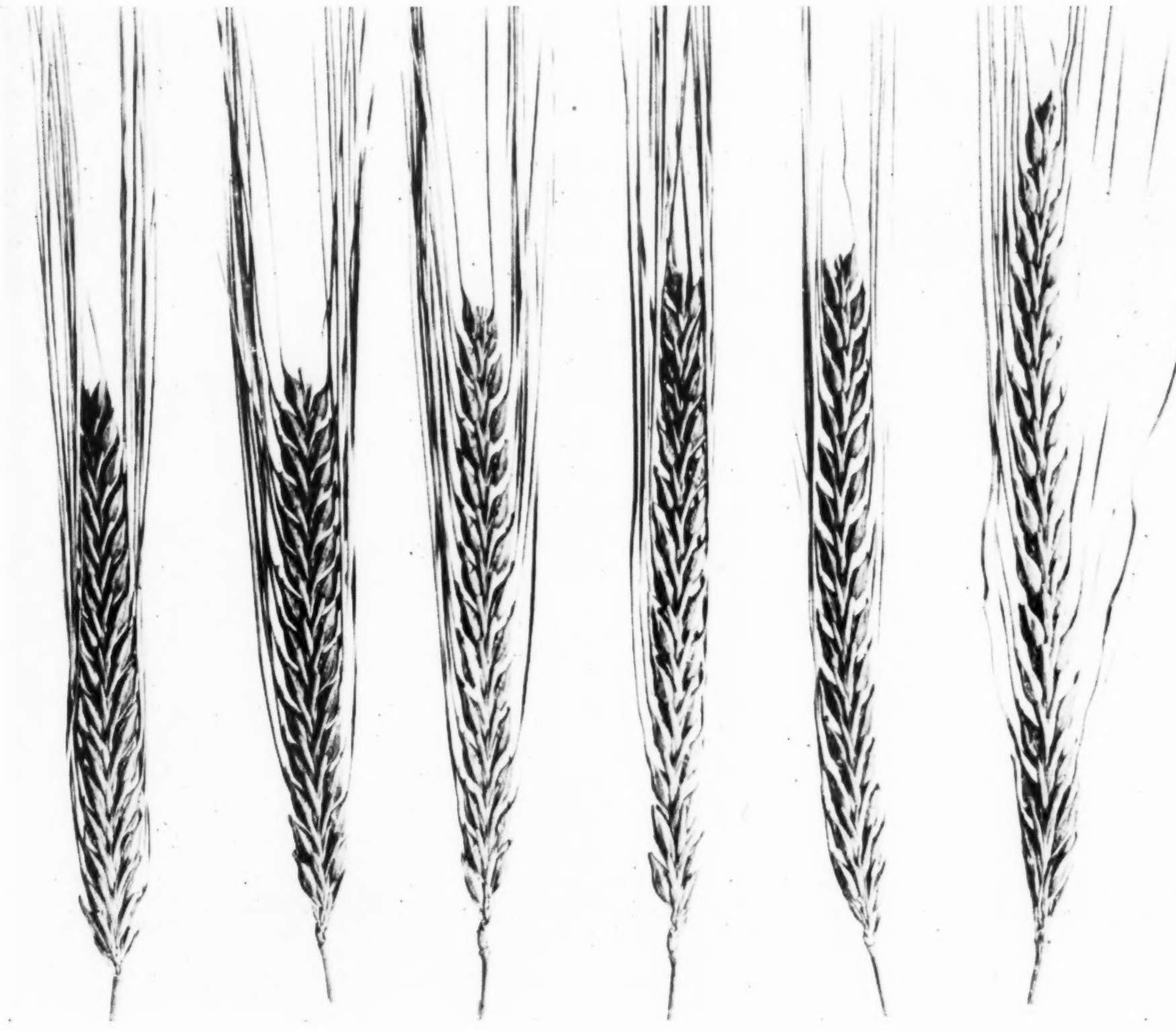
The primary and sole object of this enterprise was, then, to arrive at absolutely practical results. Scientific research was therefore only carried on in special cases, directly connected with some practical question in hand.

Nevertheless, it was fortunately understood from the beginning that only expert botanists were able to direct the variation and creation of new forms in the directions indicated, that is, to arrive at the creation of real cultural varieties, well suited to the country and more productive than those formerly in use. It was also understood that strict specialization was necessary, and that we must concentrate all our energies on this one point, eliminating all foreign activities, such as teaching, comparative field trials, commercial analyses, etc.,—activities which, elsewhere, too often weigh down the program and the staff of experiment stations.

SECRETS OF ITS SUCCESS.

It is in this unrestricted organization, with its well-selected program, its close contact with practical agriculture, and its men accessible to the latest and best methods and resources of science—it is in these points that one should seek to find how it happens that a humble provincial institution in a poor country like Sweden, under an unfavorable climate, has been able to contribute to the reorganization and improvement of plant breeding to the extent shown by the results of its work during the last quarter of a century. Another cause of its success can be found in its organization, wholly agricultural, which results from the origin indicated above, and from the character of the directors of the work.

The question of seed had been long discussed among Swedish agriculturists, when M. B. Welinder, a young farmer at Svalöf, seconded by Baron F. Gyllenkrook and many other enlightened agriculturists of the province, founded, in 1886, a local society for the improvement of seed. In a short time it aroused so much interest throughout the country, that it soon grew into the Plant Breeding



WHAT "ELEMENTARY SPECIES" MEANS.

These six forms of barley (*Hordeum distichum nutans*) were all isolated from the same mixture of types—a mixture, however, which under the old system was a commercial variety, and was sold by seedsmen as such. When the many forms in these mixed varieties are separated, distinct types or "Elementary Species" like those above pictured are found; and if they are propagated separately, each one comes true to type, forming a "pedigree culture." (Fig. 1.)

Society: "Sveriges Utsädesförening." Little by little, it received subsidies from all the Swedish agricultural associations, even those in the extreme north, and finally also from the government. At the same time, about one thousand members from all parts of the country gave it their financial and moral support.

Care had been taken from the beginning to join this enterprise with an independent association of agriculturists, in order to interest its members directly in the work being carried on, and at the same time to obtain their regular subscriptions. There are two groups of members: those who are permanent after having paid $28, once for all, and those who pay annually $1.40. A directorate of seven persons, composed of agriculturists and others interested, has charge of the administration and the finances. According to a rule adopted this year, five of the directors shall be elected by the government and two by the society itself. The society issues a periodical publication, and special bulletins when necessary. In giving advice and expert opinions, in directing comparative local trials, in examining local varieties and other ways, the society strives as far as possible to fulfil its purpose of raising the general level of agriculture in the country.

SOURCES OF INCOME.

The money necessary to carry on this work is secured from various sources.

The annual subscriptions of members give, on the average, $740 a year. The agricultural associations have contributed about $4,460 a year, and even more in recent years. Finally, the government has, ever since 1890, granted $4,200 a year and, since 1905, this subsidy has increased to $11,200. At present the yearly subsidy has been raised to $21,500; this sum includes the contributions of the agricultural associations, which will shortly be discontinued.

Finally, receipts from the sale of new creations—of which I will speak later—give a profit which has increased yearly. During the period 1901-1906 it averaged $1,450 a year, afterwards it increased to $4,400 a year, and at present it exceeds $16,000. Thus, the budget of the society for 1913 is not less than $30,000 and for 1914 $40,000.

From the payments of life members—about $10,000 in total—a fund has been set aside for buildings, much increased by donations from patrons of agriculture, which indicates the keen interest that this patriotic enterprise has awakened. The total of these donations amounts so far to $77,000.

Accordingly the society now has at its disposal a large and well-equipped establishment, comprising two connected buildings serving as laboratories, a house for preparatory work, with a little farm and a dwelling-house; it also owns 40 acres of land, of which special cultures and seed-multiplication plots occupy 25 acres. Despite this, it has been found necessary to make most of the cultural experiments on the wide fields of the huge property adjoining, in order to give the different cereals, occupying in total about 30 acres a year, their proper place in the rotation of crops, which is found absolutely necessary for a normal development.

THE DEVELOPMENT OF METHODS.

Considering that the work at Svalöf was started by farmers, and that it is the first time an attempt was made to interest theorising scientists in a question so frankly practical, you will understand that the program of work could not be otherwise than vague and fluctuating, at the commencement; it is only as the result of experience that a suitable method was by degrees found and adopted.

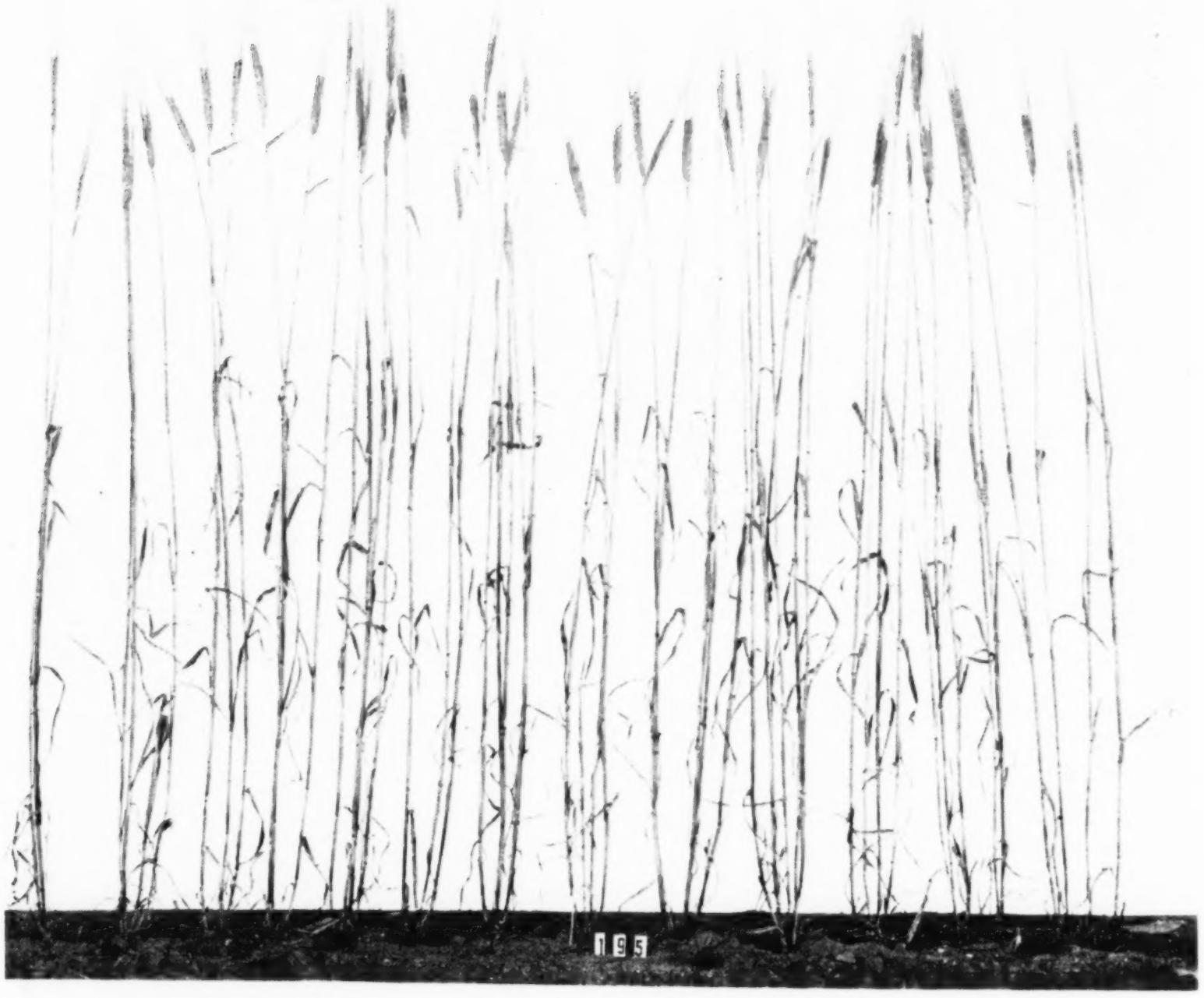
It is, then, evident that the history of this task ought to offer a picture of successive improvements, of new series of experiments, of changes and, finally, of progress; it is the more instructive because it has gone at least ten years ahead of contemporary institutions with similar purposes.

The starting point of the work was naturally the "methodical selection" accepted and practiced universally at that time, in direct accordance with the selection theory of Darwin, which was still recognized as the probable solution of the problem of the formation of species in nature.

These ideas were set forth in a way typical of the epoch by K. Rümker in his "Getreidezüchtung" (Berlin, 1889), which was looked upon, from 1890 to the end of the century, as a classic résumé of experiences relative to the question of improving agricultural plants.

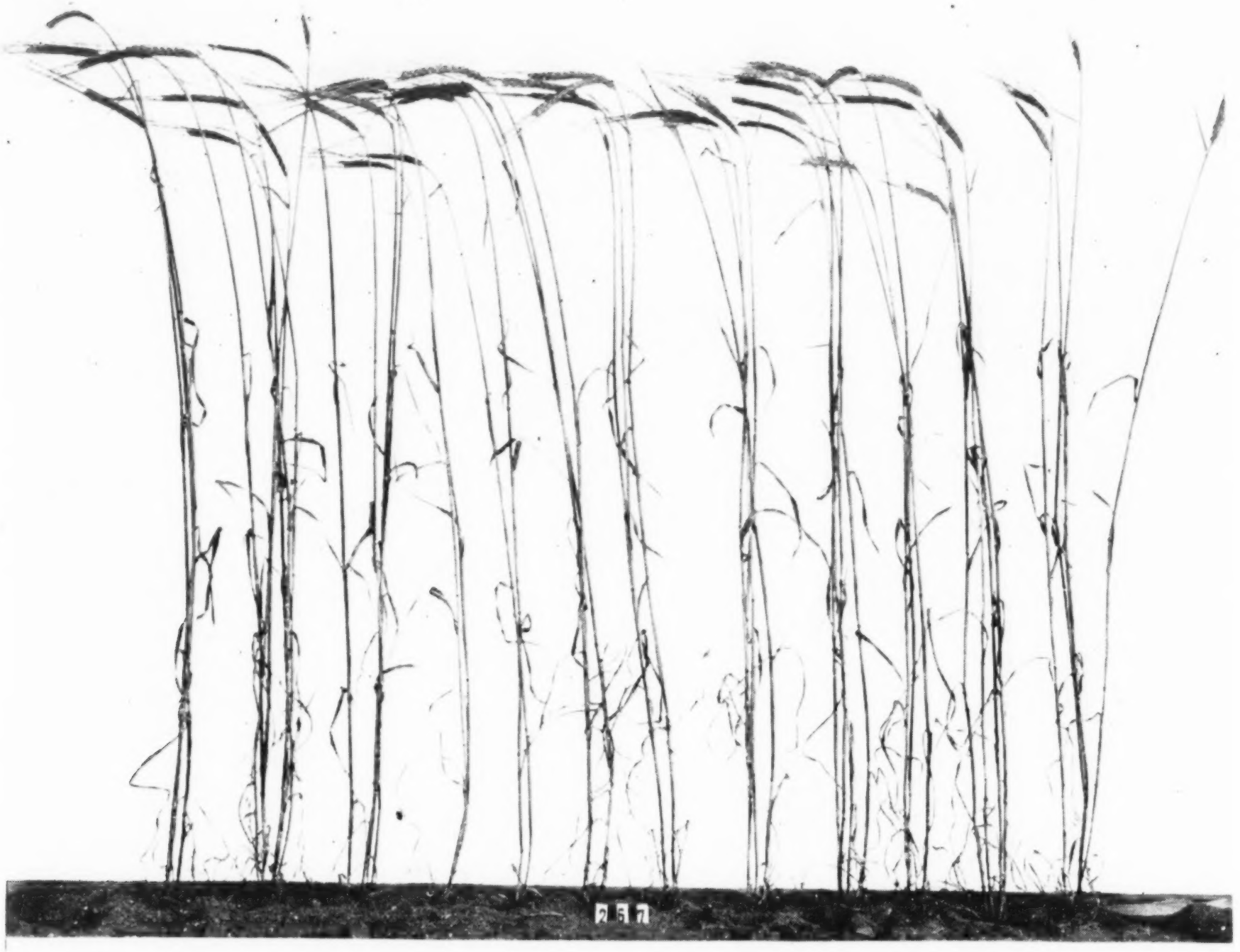
It will be sufficient here to recall that we believed a methodical selection, long continued, of plants characterized by a certain common quality or disposition would lead to the creation of a new variety which would be constant and which would have exactly that quality desired as a distinctive and hereditary characteristic. The result, it was said, would be just what was seen as the result of natural selection.

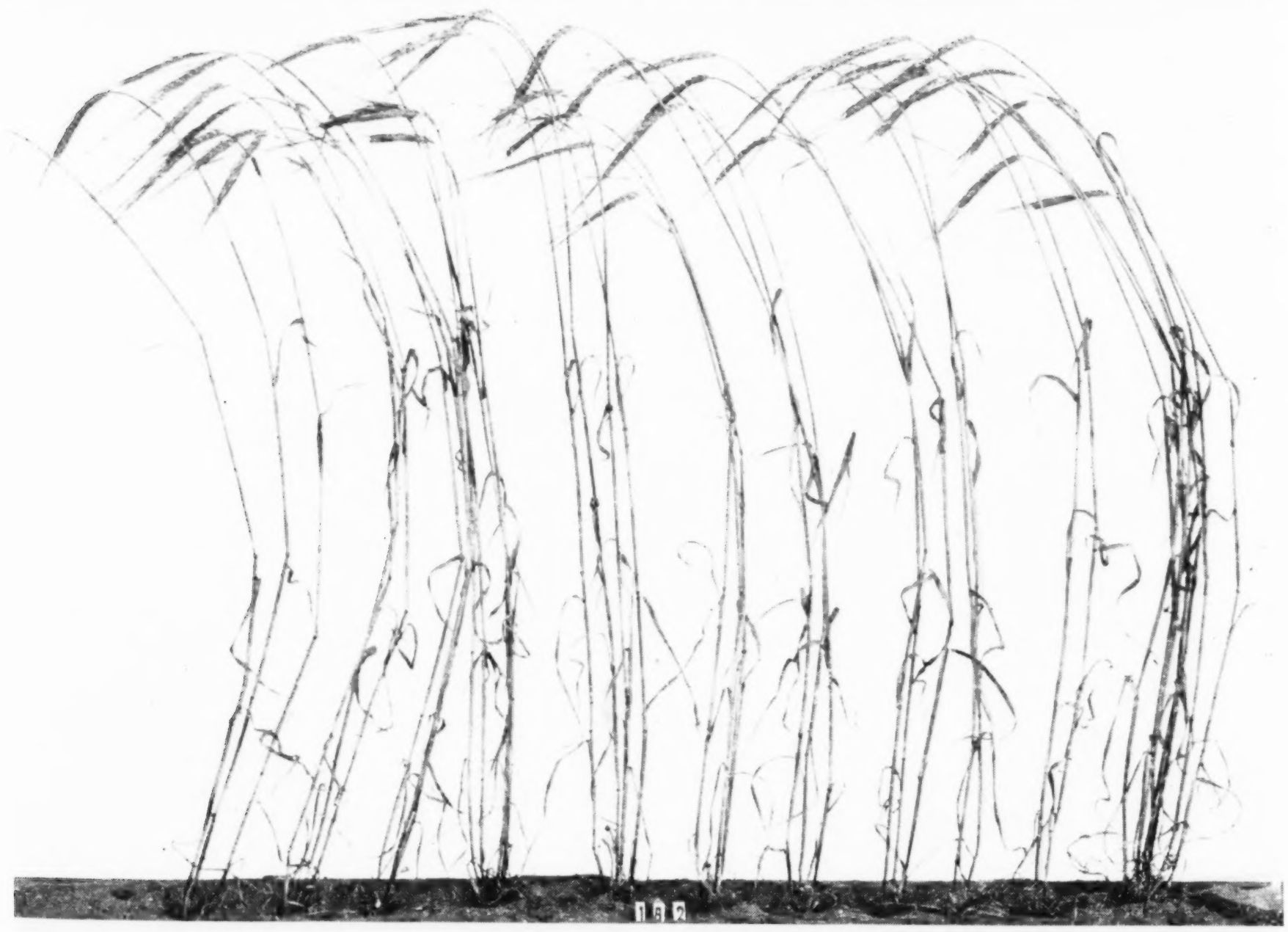
It was not until ten years later that a profound criticism of these ideas was made by Hugo De Vries in "Die Mutationstheorie" (vol. I, Leipzig, 1901), where he seriously questioned whether the progress in plant improvement which had been attained was really obtained by the method supposed, the insufficiency of which he pointed out both on theoretical grounds and by citing his own experiments. The new method of operation, by which he proposed to replace the ancient method previously employed, *had at that time already been in use at Svalöf for ten years*, as we were able to prove by the hundreds of genuinely new varieties which had resulted from its application. But, because of the frankly practical



THE PRODUCE OF A SINGLE OLD SORT.

The four constant, "pure lines" of barley (*Hordeum distichum nutans*) shown on this and the opposite page, represent cultures isolated from a trade variety that has long been sold as homogeneous. A trial proved that it was in reality composed of a great number of different "elementary species," each of which, when isolated and propagated by itself, proved constant. These photographs show four types which differ widely in habit. Taken by themselves, each one can be used according to its individual value; under the old system, which existed universally up to 20 years ago, and is still in effect in many countries, these four types would have been planted mixed together as one, and the cultivator would have had corresponding difficulty in profiting from them. (Fig. 2.)





ADVANTAGES OF "PEDIGREE CULTURE"

"In employing the old method of 'selection in mass,'" says Mr. Nilsson, "we were working blindly without knowing how or when or even whether we would some day reach stability of the type, which was more important than any other quality." It is obvious from an inspection of the photographs on these two pages, showing four types differing so widely in habit and yet taken from the same old sort, that the problem was not to be easily solved as long as they were mixed together. When they are isolated as pedigreed cultures, as here shown, "all fear of failure because of insurmountable variations is eliminated. The varieties are already there, and fixed from the beginning of the work; the only difficulty is to learn to recognize them and to place the proper valuations upon them." (Fig. 3.)

character of our organization, we had been so much occupied with the practical application of our discovery that we had never had time to elucidate the theoretical question or to lay the result of our observations before the public.

METHODS IMPROVED.

It was not without deliberation that the engineer von Neergaard, the first scientific director of Svalöf, based the work on methodical selection. He simplified methods as much as possible, made the experiments more practical, replaced "approximate" measurements of certain characters of the plants by numerical valuation of weight, number, measure, size, etc. In pursuit of this aim he invented special instruments and introduced new methods of research. He was thereby able to control objectively the resulting variations and their relative constancy. Thus, methodical selection was for the first time made the object of critical scientific study, the results of which quickly appeared.

In 1890, when I became director of the work, I had to meet the desires of the authorities who were subsidizing us by making a hasty general survey of the notes which we had compiled. In spite of the extent and intensity of the selection experiments which had been made, that inspection did not show me the results which we had a right to expect. Rigorous selection pursued during five years had produced only a relative uniformity; we could not show a single new and constant variety-character. And most of all, it was evident that our selected varieties, left to themselves for a year or two, unquestionably fell back to the condition of a mere mixture of the original varieties.

Evidently, we were unable to produce what the Swedish farmers wanted—better varieties, which would be constant. It was obvious that we must find a new method of operation which would give better results.

Such, then, was the desperate situation at the beginning of 1891.

But by the summer of 1893 the difficulties had been overcome; a new method of work was in use at Svalöf, which promised perfect results in carrying out the program which the society had laid down.

During the second year of my residence at Svalöf (1889), my botanical instinct had led me to study attentively the numerous strange forms which were found among the old cultivated varieties; by planting these strange forms, would it not be possible to produce new varieties as good as those which we had tried to create by the slow and systematic improvement of the original variety?

START ON NEW PLAN.

The work was started without delay. Preparatory experiments made in 1890 with 30, and continued in 1891 with 291 different types of spring wheat and vetch had not given satisfactory results, so I increased the number to a thousand in 1892, including all the cereals, peas and vetches which we were studying. At first the result seemed none too encouraging; yet I had occasion to observe, here and there, some novel autumn wheats, which at once opened interesting perspectives to me; they represented only five per cent. of the whole collection. They showed a uniform and characteristic type, such as we had never previously found in our plantings; it was evident that they differed wholly from the rest in value. The office records showing the origin and treatment of these plots were accordingly examined, and we found that each one of these lots came from a single head of grain, or else, what amounts to the same thing, from a single plant. Our attention was by this means drawn to the importance which the progeny of a single individul has in the plant breeding. It was a novel idea for us; appreciated from the scientific point of view, it did not fail to inspire us with great hope.

In order to obtain a definite solution of this problem, we made a general experiment with separate cultures, in our 1893 planting, using 2000 different numbers and letting each number represent the planting of the seeds of a single well-marked individual plant. The result was convincing. It left no doubt as to the fact we had discovered in our

preceding work, that the only true starting-point for the fixation of different types must be plants taken one by one; the only unity with which we should work must be the living plant itself and not at all—as had thitherto been supposed—its individual organs: the ear, the grain, etc., to which different hereditary dispositions had been attributed.

SVALÖF METHOD OF PLANT BREEDING

This discovery completely changed our outlook on the problem of plant breeding, and also—as we realized very clearly—on the methods of selection. No sooner had we obtained sufficient proof than our operations were changed and immediately directed in accordance with the new principles.

In the first place we demonstrated the existence, in our material, of a large number of independent forms, having widely divergent qualities and a practical value that was quite variable. Thanks to our separate cultures, each one deriving from a single plant—"pedigreed culture"—which was easy to control, we have found that most of the descendants are constant, and only in rare cases are they in the heterozygous condition resulting from crossing. Thus, while we had formerly been absolutely incapable of producing a single variety which would really breed true, we found ourselves from then on able to produce as large a number as we pleased of new and stable sorts, suitable for extended culture.

In employing the old method of "selection in mass" and methodical order of choice, we were working blindly without knowing how or when or even whether we would some day reach stability of the type, which was more important than any other quality.

On the other hand, if we commence by a pedigreed culture, as at present, all fear of failure because of insurmountable variations is eliminated. The varieties are already there, and fixed from the beginning of work; the only difficulty is to learn to recognize them and to place the proper valuations upon them. The principal and only decisive work thus comes *after* the fixation, and when the variety is already established and in our possession.

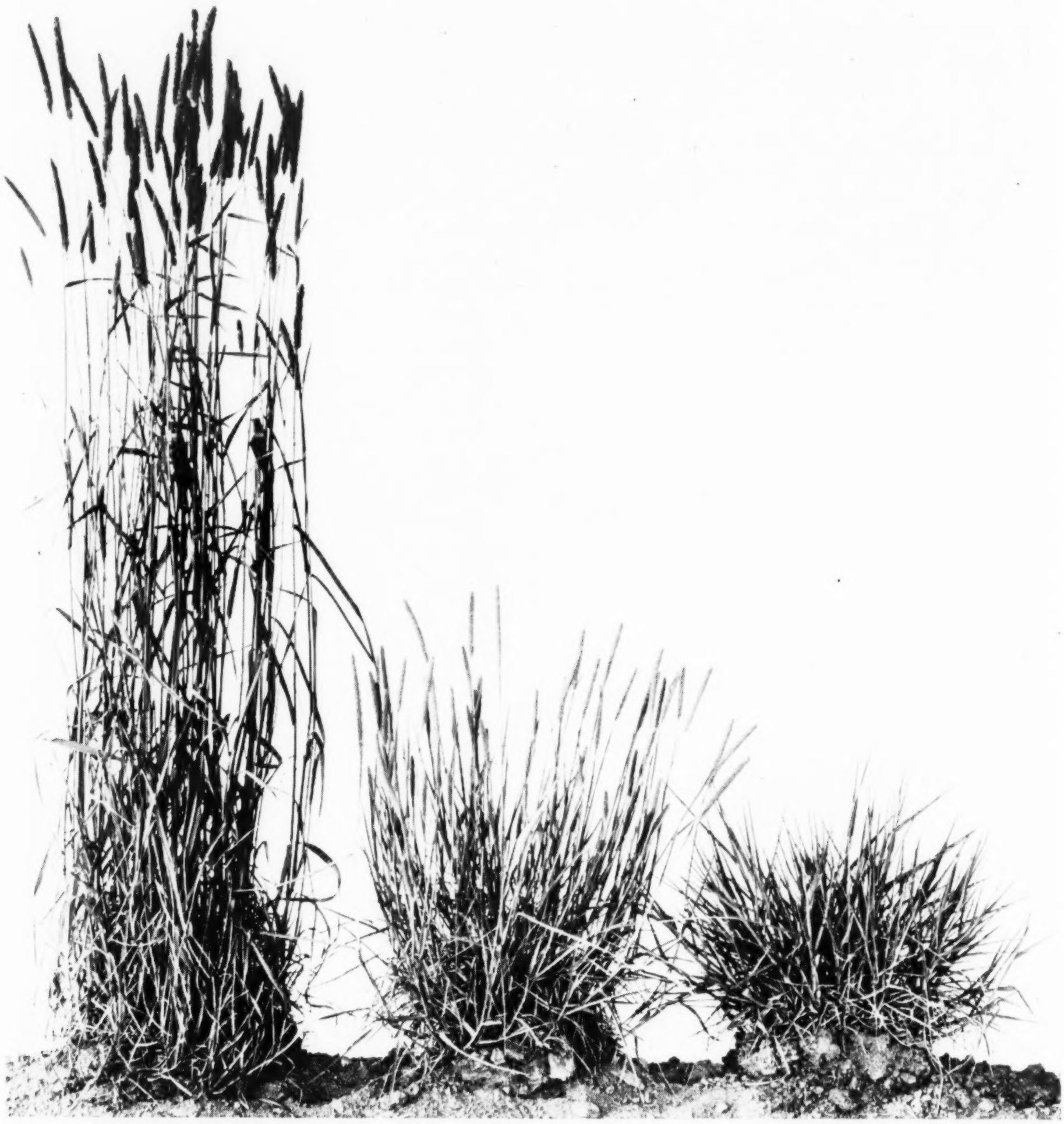
The long series of selection-operations which we had previously been obliged to make each year on thousands of plants and for their different organs—on the plant as a whole, on its straw, on its various ears, on the haulms and on the grains—all that was now superfluous, since we recognized that the plant itself was the ultimate unity, to be treated by a comparison with all the other individuals of its generation. The ingenious instruments which had previously been indispensable in our researches have now been set aside as museum exhibits, to be used at most for an occasional control-examination: the field of experience is from now on the place for appraising our results.

THE MOST ESSENTIAL WORK.

It will be understood, also, that although this simple operation created a complete revolution in our methods, pedigree-culture has nevertheless received only a secondary place among the operations at Svalöf. It has become only a preparatory and practical auxiliary for getting out properly the material which we desire to utilize. The greatest interest and the most essential work, on the contrary, remain in further investigation of the practical value of the innumerable little elementary species.

The decisive qualities of each species being surprisingly numerous, and combining with each other in related forms according to a fabulously rich scheme, the determination of their comparative values becomes an extremely arduous task, the more so since it is necessary to start with as large and varied a collection as possible, if we want to have a chance really to find the best. Accordingly, since that time the principal work of Svalöf has been connected with these problems. That is why it has become so preponderant, why it has stamped its character on the whole system at Svalöf.

The first thing to do was to divide up the work among the competent persons available, in such a way as to give to each one a limited field, comprising one



THREE TYPES OF TIMOTHY

Under the old system of seed production, a commercial variety containing all three of these sorts of timothy (*Phleum pratense*) would have been given to the farmer, in spite of the fact that they differ so widely in habit and blooming time. Under the modern system, the commercial material is sorted out (by actual planting tests) and each component part isolated, and made to stand on its own merits. (Fig. 4.)

or two cereals. Then, by profound study of his own material, by rigorous research and field trials, each one was able to become an expert in his special branch, training his eye to distinguish first of all the different forms, and next the relative value of existing characters.

Thus prepared, we became able to establish an exact systematic classification of the different species, the only means applicable to obtain a comprehensive survey necessary to the study of polymorphous material. The first comparison was between the groups thus limited, and the second an examination of the different sorts inside these groups.

The fact that we have usually succeeded in making natural systems out of these classifications, where char-

acters which are clearly morphological indicate to us the absence or presence of qualities determining the practical value, is an advantage which can not be overestimated. It makes it possible for us to make some progress, at least, toward the desired goal, from the moment that the first generation is examined.

THE USE OF PRACTICAL TRIALS.

For the final and decisive determination of agricultural value, we have had on the contrary to depend on practical trials. It was thus a great advantage to our Institute to have a strictly agricultural organization and equipment, due to its close relations with practical men. It is solely the progeny of these "élite" parents, cultivated in an ordinary field under normal agricultural conditions, that determines the practical value of the inherited qualities of the numerous new forms. To reach the final decision, cultivation and careful examination during a long series of years are ordinarily necessary.

In order to be able to apply all these processes with exactitude, and with the order necessary when thousands of forms are dealt with (in 1912 there were more than 9500 numbers in our trial grounds) we have had to invent numerous practical arrangements. We have had to establish special genealogical tables, corresponding to the systems of fixed forms, with a numerical arrangement applying to the parallel genealogical collections which we made, as well as to the trial grounds, the records, the labels, etc. The interior arrangement of the work rooms, and the whole organization of the laboratories, had also to be on lines which were absolutely systematic and easily inspected. We have reached the point where we have at Svalöf an establishment that is probably unique in its complete adaptation to its own method of independent work. Our institution and our method thus comprise, together, a unity which promises to perpetuate both our special system and the intensity which has always marked our application of it.

In its broad outlines, this order of work was established in a very few years; so we were able to demonstrate its operations for the first time at the general congress of Swedish agriculture in 1896, by several hundred varieties which were new and stable, and under comparative observation. During the course of our work it was also obviously stated how numerous and decisive the lines of progress were which we had already utilized practically for the benefit of Swedish agriculture, before it had been even realized in other places what we were trying to do.

WORK ON WIDE BASIS.

By the infinite number of stable forms which with this came to light in our culture material, the amelioration of economic plants had a basis far wider than the old method could give, with its limited number of chosen varieties; the possibilities of producing valuable novelties were increased, because the qualities at our disposition varied widely, and among them—as our experience soon showed—are included the season of maturity, cold-resistance, disease-resistance, etc., qualities which are of a great practical value, but which had previously been quite inaccessible to the work of plant breeding.

Since the forms which we regard as varieties are systematic and independent unities, although of secondary order, the fact that they breed true considerably extends their possibilities, for they can be propagated without the necessity of renovation too often by the purchase of new seed.

The constancy which distinguishes them concerns many characters and qualities, as to whose transmission we had never dared to depend. As it persists in a notable degree among all the plants—at least, during the early generations—whatever there is in the variety in question of a particularly inheritable nature becomes more obvious than before, a circumstance which greatly facilitates the expertising and the control.

It is very true that the most specialized kinds demand more judgment and care on the part of the cultivator, but they equally increase his chance of as large a financial profit as possible, when he has learned to make a judicious

SUCCESSFUL BARLEY HYBRIDIZATION

In the center is shown a new and constant form of barley with stiff, erect ears, which resulted from a cross between two very "nutant" old sorts: *Hordeum distichum nutans* (at the left) and *H.d.erectum* (at the right). Hybridizing experiments on an extended scale at Svalöf only date from the beginning of this century, but it is evident that much of the future progress will be by that means. (Fig. 5.)

choice among the strains, in accordance with local conditions. Considering the keen competition of our days, this judgment becomes more and more a vital question for modern agriculture.

It is especially for the people of the North, who, because of their climate, their isolated situation and the varied character of their soil, can only rarely get their seed supply from more favored countries—it is for these people that a method of selection, based on the very heterogeneity of the material, necessarily must have an inestimable value. It is only by this means that we shall be able to use the eventual values of our old, native races; inferior as sorts, they nevertheless offer, by their most serious defect—polymorphism—exceptional chances for the selection of a better variety.

With the same motive, we can handle the species and native races of all countries by this method, no matter from what climate they come or what their nature may be, for we everywhere find a diversity of forms offering ample room for selection.

INSTITUTE REACHES ITS GOAL.

In establishing this method of work, the order of procedure in which has been reversed since the valuation of qualities is made on varieties already

fixed and with the aid of the auxiliary associations whom we serve, we may say that the Institute of Svalöf has reached its essential and peculiar goal, and that it has attained for itself a memorable and incontestable place in the history of plant improvement. Following its example, all analogous contemporary operations have successively passed from selection in mass to the utilization of the qualities of hereditary character, studied on an isolated plant, although sometimes under different names, such as "individual selection," "selection by families," etc. Separate culture and separate judging have also been, and still are, conditions necessary to the practical application even of discoveries made later concerning the value of different qualities as mobile, hereditary units.

I would certainly not wish to be understood as saying that propagation of separate plants had not previously been made by cultivators like Shirreff, Vilmorin and Hallet. But it is certain that not one of them, not even Vilmorin, had ever realized such great possibilities of this simple procedure, as we had discovered and applied in practice here at Svalöf 20 years ago.

Furthermore, their experiments in this direction were, at the beginning of our experience, so completely forgotten and ignored in practice, that it was necessary for us, as I have already said, to discover the fact anew.

The reader may well ask of what nature are all these little elementary species, which have allowed the old material to be sorted out into independent new sorts? Do they come from mutations, from natural cross-pollination, or from both together?

It is a fact well authenticated at Svalöf that mutations appear from time to time in our cultivated plants. Furthermore, we have found that spontaneous fecundation is much commoner than we had supposed. But it must not be imagined that we can discover with certainty, in each particular case, the origin of all the forms—and anyway, the knowledge of how they originated does not trouble our practical work, for which the fact of their existence is sufficient. Finally, it must be noted that the significant results furnished by diverse methods of origin are the same in the two cases, that is to say, they lead to the possession by each group of a multitude of systematic unities, differing from each other in the way their characters, often few in number, are combined. They are all what have been called "minute species" or "elementary species." Mr. Johannsen, who later examined them carefully, has described them as "pure lines." Here we have retained for them, for practical reasons, the English name of "pedigrees."

IN CROSS POLLINATION.

Although we did our first work of this kind with self-pollinating species (wheat, barley, oats, peas, vetch), we have later, in dealing with rye, clover, forage grasses, beets, etc., had occasion to convince ourselves that the existence of these small species, quite analogous, is clear in plants which are not self-fertilized. With these, of course, we do not find the pure lines immediately upon isolation. They require systematic treatment during some years, to offer a satisfactory degree of purity and stability, which even then can never become so perfect as among self-fertilized species. But it is already proved that by the aid of such forms we can reach the same practical results as by the aid of the elementary species. The extension of Svalöf Institute has as its principal object to make the treatment of these groups of crossed lines more intense by the fixation of the forms, followed by their careful valuation.

Among the means of securing new forms of cultivated plants, I must also also mention artificial hybridization. About 20 years ago, when we were entirely occupied in profiting from the precious forms which an exploration of our old varieties had given us, we had no chance to study this method seriously. Furthermore, the extended experiments with cereal-hybridization which we made some years later (1897-9) did not give encouraging results. Nevertheless, the fall wheat Svalöf Extra Squarehead II, finally so famous, dates from that first series of crossings.

MENDELISM IN OATS

In the upper row are Svalöf's Klock Oats II (at the left) and Svalöf's Stormogul Oats (at the right). Each of these "pure line" sorts has one mendelian factor which causes spreading panicles. The factor in Klock Oats (A1) is, however, distinct from that in Stormogul (A2). When the two sorts are crossed, the genetic formula will be A1a2 x a1A2, capital letters denoting presence of the factor for spreading panicles, and small letters absence of it. When the factors are distributed and combined in the germ-cell, one combination will arise lacking both positive factors, and represented by a1a2. As this oat will lack altogether a factor to spread the panicle, its appearance will necessarily be quite different from that of either parent; as a matter of fact it grew up to be a "sideway panicle" oat, shown at the right in the lower row. Another combination of the factors brought both positive factors (A1A2) together in the same cell; and the oat with this "double dose" of spreading-panicle factor appears to be even more spreading than either parent. It is shown in the lower row, at the left. The rest of the oats from this cross were represented by the factors A1 a1 or a2 A2—that is each possessed one factor for spreading. These two types, when grown, were indistinguishable, and looked about like their parents, as shown in the center of the lower row. (Fig. 6.)

Gradually, as we obtained a large enough collection of new and well-known lines, characteristic and stable, each one with a superior quality of practical worth, it was natural for us to seek to obtain still more valuable combinations among these qualities by hybridization experiments, well planned and systematically executed. That is, accordingly, what we have had in hand since the commencement of this century.

HYBRIDIZING IMPORTANT.

Since the researches of Mendel, so fundamental for the study of hybridization in general, have again become accessible, this sort of work has been much increased at Svalöf. It is especially by the widely-known studies on oats and wheat of Dr. Nilsson-Ehle that remarkable contributions have been furnished by actual investigation of the phenomena of this category. The new light thrown by them on the problems of heredity and variation has a really great influence on improvement. The new laws which teach us to think of the different characters of the plants as behaving like autonomous unities from the very beginning, are also important in our work.

It is incontestable that these discoveries still further increase the possibility of progress. It appears that, particularly in Sweden, it will finally be possible for us to create by this means an agricultural material adapted to the most northern latitudes, which will add to general good qualities a greater cold-resistance or earlier maturity.

However, the application of this method in a widespread way at Svalöf shows that the combination and breaking-up of qualities, ordinarily very complicated in products of hybridization, makes very illusory the hope of reaching results based solely on theoretical calculations. That is an inconvenience which we must endure, however, since hybridization offers so many chances, even if they are vague, which we could not otherwise obtain.

In any case, hybridization as we practice it at Svalöf with our varieties already fixed, must be considered only as a supplement of our original method of selection in pure lines, and not at all as replacing it. Every hybridization experiment demands as starting point a pure and constant material with well-known qualities—consequently, that is what we must first produce. Besides, the final evolution of the process of hybridization depends on the continual creation of new material superior to that which preceded it. To produce these two types of indispensable material, we must continue to employ our method of selection, which is the best and most efficacious for the discovery of the most precious and most constant components in the old, mixed varieties. In addition, selection in the extremely variable products of hybridization is practiced indiscriminately with the older style of selection in our work at Svalöf.

Although the Institute of Svalöf has already given, and probably will still give, as rich contributions to Mendelism as any of its contemporaries, it must never be forgotten that its main work, its specialty, will always be the hunt for novelties by its own, original method, which must never be set aside in favor of the other work of improvement following this. Furthermore, for a large and important part of the material treated, such as the forage plants and root crops, the time for hybridization will only arrive in the distant future.

GROWTH OF THE WORK.

The crops dealt with at Svalöf have been fall and spring wheat, rye, barley and oats and also, since 1889, peas and vetch. Oats were, however, not given intensive study until after the adoption of the new method in 1893 and rye only in 1900. The original program included other crops, but these have had to wait until larger subsidies are available. It was not until 1905, when the government made an allowance of $7,000, that we were able to take up the improvement of forage crops, clover and potatoes. The root crops have not yet received any keen attention, although they will be given it as soon as the financial reorganization, of which I have already spoken, is completed. It is true

that they have been studied, for some time, but principally after the simplest pedigree method and by selection in mass. With these, all the Swedish crops will have become the object of improvement at our institute.

As I have already remarked, the intensive studies which our new method necessitated led to a division of labor in such a way that each specialist received a limited field for which he was responsible. Thus I took charge of oats and wheat in 1890, and in 1899 turned them over to Dr. H. Nilsson-Ehle. P. Bolin had barley from 1892 to 1896, when he was replaced by Dr. H. Tedin, who since 1892 has also had charge of the Leguminosae. J. Walldén was in sole charge of rye from 1901 to 1904 when he divided it with E. Ljung, who since 1908 has been in entire control of it. Dr. Lundberg has worked with the potatoes since 1905; forage plants were taken by me in 1904, but turned over in 1907, with clover, to Dr. H. Witte. Root crops have been handled since 1907 by I. Karlsson. Mr. Walldén has directed the work of controls and germination since 1892.

It is evident that the final results have no practical value except in the same conditions under which the experiments were made, and that a change of climate and soil might entirely change their value. In a country like Sweden, which extends over thirteen and two-thirds degrees of latitude, that is to say, over a distance from north to south as great as that from our south coast to Rome, it is absolutely necessary to make numerous tests in different parts of the country. As soon as we had produced at our institute, situated in southern Sweden, a large number of varieties which we thought suited to the central part of the country, we began to arrange numerous local trials each year. Soon we had to form special branches, in order to make serious and properly-directed tests. We have now two branches, one since 1894 in central Sweden, near Upsal, and the other near the arctic circle at Luleä, which was organized particularly for the study of forage plants. Our plans contemplate the creation of other branches in the most important agricultural provinces.

NEW VARIETIES OBTAINED.

As I have already pointed out, the Swedish agriculturists, in founding their breeding station at Svalöf, intended principally to obtain new varieties suited to their country. In passing judgment on the work of the institute, it is therefore necessary to limit one's self to a consideration of the varieties put in the trade, and their success.

First, it can be said that our varieties have become established throughout the country to a surprising extent. In the principal agricultural districts, and for certain cereals, they have almost entirely supplanted the old varieties, as well as those later introduced from abroad. The only explanation of this is that the institute and its specialists have always kept in the closest touch with the farmers, who are, in fact, in a majority on the directorate. Thus the real needs of the farmers were known, and the attempt to supply them has always been the guiding principle of the work. It has been our principle and practice to introduce into the trade as few varieties as possible, letting nothing go out that was not absolutely superior. However, the wide range of climatic, cultural and industrial conditions has made it necessary for us to furnish a group of varieties of each cereal, rather than a single superlative one. I can best make this clear by surveying the varieties of Svalöf origin which are now actually in the trade; but it must be remembered that some sorts placed on sale, although meeting with public favor, have been withdrawn when it was possible to replace them with a variety of the same type but better quality.

TWO SERIES OF WHEAT.

There are two series of fall wheat, one for the southern provinces, where the climate is favorable and we have bent our energies to producing varieties with large yield (*Grenadier*, *Extra Squarehead* II, and *Sol*), and the other for the more rigorous climate of the central provinces, where cold-resistance was the

ORIGIN OF A GRAY LINE OF OATS

The principles of Mendelism were prettily exhibited in a cross of black and white oats (shown in the top row, above). The first generation was all black, like one of the parents; it is shown as a single seed in the middle row. The second generation, shown in the lower row, segregated as was expected into the Mendelian formula: 12 black, 3 gray and one white. The genetic explanation as given by Dr. Nilsson-Ehle is that the black parent strain (BG) had one factor for black (B) and also one factor for gray (G); but the gray color was covered by the black. The white sort, of course, lacked both black and gray, and is therefore represented by the symbol bg. Among the possible combinations of factors in hybridization, is bG, the plant of which will lack the black factor but possess the gray: its color, then, will be pure gray, without any trace of overlying black, just as is shown in the three seeds of the lower row. The one white seed is known as the "extracted recessive"; according to the prevailing theory, it is white because, lacking factor for either black or gray, it could not be anything but white: in other words, it is a mere case of presence or absence of color, which is shown to be heritable by purely mathematical formulae, based on the Laws of Chance. (Fig. 7.)

preëminent requirement (*Renodlad Squarehead*, *Bore*, *Pudel*). In the south our varieties have already supplanted the native ones, but in the center, the old ones are still much employed, since we have not wholly gained the hardiness necessary. From our new series of hybridizations we hope to produce the ideal. For spring wheat in that latitude an early maturity is the prime requisite, and we can point to great progress in that direction (*Pärl*), but still have some hybridizations to make with the native varieties before attaining perfection.

As for barley, the breweries have dictated the qualities needed, not only as to general good quality (*Chevalier* II) but also for the amount and stiffness of straw (*Prinsess*) and for precocity (*Hannchen*, *Gull*) which allows culture in the more northern provinces. A second group is composed of varieties adapted to solid, moist soil, and satisfactory for brewing (*Primus*) as well as for forage (*Svanhals*).

In oats we have to meet the needs of certain provinces which require black varieties early (*Fyris*), with stiff straw (*Klock* II) or late, productive sorts (*Stormogul*) and on the other hand, to satisfy the demand for white or yellow varieties, yielding heavily although rather late (*Seger*, *Kron*, etc.), and others more precocious for northern provinces (*Guldrägn*, *Dala*). In order to meet the requirements of provinces still further north, where oat growing is still important, we have had again to fall back on hybridization, and have already made enough progress to inspire us with great hopes.

In rye, we have combined high yield, great hardiness and good commercial quality (*Stjärn*).

As for peas, we have produced both the kitchen varieties (*Concordia*, *Kapi-*

tal) as well as forage varieties for use in ripe state (*Gröp*) and as green fodder (*Solo.*) In vetch, there is need of varieties for fodder, and for seed (*Grä* and *Sät*).

Among the forage grasses, we possess various varieties taken from early, medium and late wild forms to produce meadows of uniform development. Here the natural flora of the country has furnished us material far superior to that of the tradesmen. In dealing with clover, we have principally utilized the indigenous varieties, which are perennial, hardy and highly productive. Our demands in respect to potatoes differ widely from those of the continent, since the alcohol industry is highly localized here. In general, however, precocious varieties are required.

Finally, it is universally admitted that the society has contributed in many other ways to the progress which Swedish agriculture has made during the last twenty years: for example, by its propaganda in favor of more scientific agriculture, by its advice and directions, its demonstrations, field trials, etc., but most of all in raising the standards of the seed trade throughout the country, an elevation made possible by its control of the wholesale trade of its own sorts. By all these means, the real value of the perfected seeds has been made known, and the farmers have learned to raise their demands to an extraordinary height.

OUR INFLUENCE ABROAD.

As we have seen, the Institute of Svalöf was founded by Swedish farmers to serve their common interests. In organizing and achieving this task, therefore, the society had in view, as it still has essentially in view, only the needs and possibilities of Sweden. Furthermore, it is obvious that varieties selected for their adaptation to as peculiar and northern a climate as ours would be valuable only to a limited extent in a country with different physical conditions. Nevertheless, in so far as concerns the continent of Europe north of the Alps, excepting central Russia and certain parts of Austria, it seems that a considerable number of our productions are well adaptated to foreign conditions. Accordingly, they have been propagated there to by no means an inconsiderable extent. It has been proved that varieties like the barley *Hannchen* and the oat *Guldrägn*, maturing early, have accommodated themselves to an unexpected degree, even to extreme conditions.

Thus, to cite only a few examples, the new oats are widely employed and much appreciated, particularly in Russia. Most of our varieties are much cultivated in Germany, Denmark and Holland, and more lately in England. In France our brewing barleys, and also our oats, are regarded with great favor. In Canada and the United States many varieties are in use, in definite and circumscribed areas. And in all the rest of the world isolated experiments have been made with our productions, under the most diverse conditions, and with the most diverse results, as was to be expected.

Beyond this, it becomes daily more evident that the method of organization of plant improvement which was originated at Svalöf has been studied by practically every civilized country and adopted as a model. The questionnaires which arrive from all directions, and the frequent visits of specialists of all nations, are sufficient proof of this foreign interest.

But I would be going too far, if I entered into a discussion of this subject. Let me conclude by recalling that selection in mass, which was generally employed even ten years ago, is at present abandoned. Both young and old breeders have now adopted the plan of separate culture, starting with single plants—that is to say, the very principle on which we established here at Svalöf, in 1893, our new method of plant improvement.

Second Report of the Committee on Immigration of the Eugenics Section of the American Genetic Association

Alexander E. Cance, Amherst, Mass.
James A. Field, Chicago, Ill.
Irving Fisher, New Haven, Conn.
Prescott F. Hall, Boston, Mass., Chairman.
Robert DeC. Ward, Cambridge, Mass., Secretary.

THERE has been one change in the membership of this Committee since the last report, Professor Franz Boas having left the Committee and Professor Irving Fisher, of Yale University, having taken his place.

A second year of study of the problem of immigration on the part of your Committee has resulted in a renewed and more profound conviction of the necessity of arousing intelligent and unprejudiced public opinion in this country to the need of strong and concerted action in favor of a more effective immigration law.

We have hitherto left the choice of the fathers and mothers of the future Americans largely to the selfish interests which care very little whether we want the immigrants they bring, or whether these people will be the better for coming. Steamship agents and brokers all over Europe, and even in Asia and Africa, are today deciding for us the character of the American race of the future. The steamships and railroad companies, and the large employers of cheap labor, have vast financial interests at stake. They want unrestricted and unselected immigration. They are well organized, and have very great influence in Washington. None of these "interests" care in the least for the sanity or for the physical soundness of our race. If their pocketbooks are well filled they rest content.

To counteract these influences and to point out wherein our immigration laws need strengthening for the better protection and preservation of the race is a duty which the American Genetic Association may well take the lead in performing.

This Committee finds that, in spite of the present law which prohibits the admission of insane and mentally defective aliens, our institutions are filling up with these very persons, and what is still more serious, there is a rapidly increasing number of mentally defective aliens at large in our communities, in no way segregated, and free to reproduce their kind. Abundant evidence and statistics of the serious conditions which now exist, and are rapidly becoming worse, is contained in the *Report of the Committee on Inquiry into the Departments of Health, Charities, and Bellevue and Allied Hospitals in the City of New York* (1913), and in the *Report of the Special Commissioner on the Alien Insane in the Civil Hospitals of New York State* (1914), to which this Committee would call special attention. It appears that while the foreign-born in 1910 constituted 30.2% of the entire population of New York State, the foreign-born insane constituted 43.4% of the patients in the State hospitals Sept. 30, 1912. Furthermore, there is a gradual decrease in the native-born percentages of the admissions and a corresponding increase in the foreign-born percentages. Dr. Spencer L. Dawes, the Commissioner on the Alien Insane, says, "If the increase in the percentage of the foreign-born be continued at its present rate for about 10 years longer, the foreign-born admissions will equal in numbers the native-born." Dr. Dawes points out very

clearly the defects in our present immigration law in the matter of the admission and deportation of alien mental defectives, and suggests the amendments necessary to improve existing conditions. Many of these proposed changes, this Committee is glad to note, have been adopted by the Committee on Immigration of the United States Senate, and are included in the Immigration Bill which has been reported to the Senate. Dr. E. K. Sprague, of the U. S. Public Health Service, has estimated that probably only 5% of mentally defective aliens who come to our shores have been detected, and about 25% of those who are or who will become insane. This Committee is entirely in accord with Dr. T. W. Salmon, also of the U. S. Public Health Service, and now Director of Special Studies of the National Committee for Mental Hygiene, when he says: "There is no reason for the acceptance of a single insane or mentally undesirable alien except inability to determine his condition. This does not require restriction of immigration, but a sensible selection of individual immigrants, in the interest of our own country and wholly without reference to the interests of foreign countries or foreign steamship companies."

SENTIMENT BEING AROUSED.

Each year brings increasing evidence that those who are most concerned about the maintenance and the improvement of the physical and mental well-being of our race are turning more and more to the regulation of immigration as one of the most obvious means of accomplishing their purpose. Thus, in the *Report of the Committee to Study and Report on the Best Practical Means of Cutting off the Defective Germ-Plasm in the American Population* (Eugenics Record Office, Bulletin No. 10B, 1914) we note the following: "The Federal Government must co-operate with the states to the extent of excluding from America immigrants who are potential parents and who are by nature endowed with traits of less value than the better 90% of our existing breeding stock." . . . "The Federal Government which has control of immigration owes it . . . to the American people on biological grounds to exclude from the country this degenerate breeding stock."

A serious situation which arises from the non-enforcement of the law for reasons of "sentiment" and of "humanity" deserves attention. No one who is not acquainted with existing conditions can possibly realize how strong, how steady and how effective is the "pull" which is exerted by the families and the friends of aliens who by the laws of the United States ought clearly to be debarred, to have those aliens landed. The steamship companies; the societies to which the alien's relatives belong; sentimental but woefully misguided "philanthropists," and Senators and Congressmen who are trying to please their foreign-born constituents—all these interests unite to bring pressure to bear upon the immigration officials to whom appeals are referred. Obviously, the oftener such appealed cases are admitted, the more lax does the preliminary inspector tend to become, and the less frequently do the Boards of Special Inquiry, in the first instance, recommend deportation. Those who want our incoming aliens to be sane and sound and fit ought to stand behind every honest immigration official who does his duty well; and ought to see to it that there is no relaxation in the enforcement of our laws, to the detriment of the race. Former Immigration Commissioner Williams well said: "We are not called upon to endanger the future of our country or its institutions for the sake of the distressed of other countries, however much their condition may arouse our sympathy. The time has come when it is necessary to put aside false sentimentality in dealing with the question of immigration . . . and in determining what additional immigrants we shall receive to remember that our first duty is to our own country." Another has stated the case thus: "These (immigration) authorities should be made to understand that in their attempts to be kind to the immigrant they may be cruel when they help to fasten upon this country a never ending burden of the care of a mentally defective strain for which we as a people are in no way responsible."

Under the vote of the Association by which the Committee on Immigration was organized, it was given "authority to co-operate with similar Committees of other organizations in securing laws which will be more effective in securing immigrants who bring good health and normal and superior heredity to this country." Following these instructions, the Secretary of this Committee attended a Conference held in New York City, Nov. 15, 1912, at which the most important scientific bodies in the United States which deal with the treatment and prevention of insanity were represented, viz.: the American Medico-Psychological Association; National Committee for Mental Hygiene; New York Psychiatrical Society; New York State Charities Aid Association; Committee of 100 on National Health; New York State Hospital Commission. At this conference the whole question of the more effective detection, exclusion and deportation of insane and mentally defective aliens was discussed. The results of these deliberations were embodied in a series of Resolutions which were transmitted to the President and to Congress. The Immigration Bill which passed Congress during the winter of 1912-13 embodied several of these recommendations. Two members of this Committee (Messrs. Hall and Ward) went to Washington to attend the hearing which was given by President Taft on the Immigration Bill, and urged that the Bill should become a law. The President, as will be remembered, vetoed the bill, which was at once passed over the veto by the Senate (72 to 18) and failed by half a dozen votes of being passed over the veto by the House.

ATTITUDE OF EUGENISTS.

The Chairman and the Secretary of the Committee have further carried on a considerable correspondence, and had many conferences with immigration and other public officials, and officers of the Public Health Service, in regard to the workings of the present law, and have also given numerous addresses on the eugenic aspects of immigration.

In the present agitation concerning pending immigration legislation the question naturally arises what attitude those who are most interested in the eugenic aspects of alien immigration should take in regard to any proposal for a further *restriction* of immigration by means of such a requirement as the "reading test," embodied in the immigration bill which was vetoed by President Taft. It is clear that the sentiment in Congress is strongly in favor of combining more effective regulations in regard to the mental and physical condition of our incoming aliens with a further amendment which will be somewhat restrictive. When a further restriction of immigration is recommended, because "demanded by economic, moral and social considerations," by an unprejudiced and competent body of experts like the U. S. Immigration Commission, eight out of nine of whose members recommended the "illiteracy test," and by Congress, as evidenced by the large majorities in favor of such measures, then we must have very excellent reasons for disagreeing with those conclusions. A decrease in numbers, especially of those aliens who are unskilled laborers, and who are the most ignorant, will have a very important and direct eugenic result in relieving the congestion in our overcrowded cities; in diminishing economic stress, and therefore in improving the mental and physical conditions of the aliens who come to us. The more skilled and the more intelligent the alien, the less he tends to crowd into our cities; the less liable he is to become insane or mentally unstable from the strain and stress of the life in our congested city districts. Dr. T. W. Salmon has clearly pointed out that 'More will be accomplished in the exclusion of insane immigrants, and of those destined to become insane a short time after their arrival, by measures which broadly restrict immigration than by any measures, however effective, which are directed specifically against insane immigrants, for any measure which will check the flow of immigration in general must necessarily result in the admission of fewer undesirable immigrants." Those who are particularly interested in the eugenic aspects of our immigration problem have many reasons

for joining hands with those who have the economic aspects of it most at heart, in the campaign for the better regulation of alien immigration to our sho es. This committee, however, has not deemed it within the scope of its own work to consider the economic aspects of our immigration problem.

On Feb. 4, 1914, the House of Representatives by a two-thirds vote, passed an immigration bill (H.R. 6060) which is essentially the same as that which was vetoed by President Taft. A similar bill is now before the Senate. Regarding the present legislative situation a majority of the Committee has agreed upon the following resolution: *Resolved:* That the Committee on Immigration of the American Genetic Association respectfully urges upon the Senate of the United States the importance of the passage, at the present session of Congress, of an Immigration Bill similar to that which passed the House of Representatives on Feb. 4, 1914 (H. R. 6060), embodying provisions which, if enacted into law, would unquestionably result in a more effective detection, exclusion and deportation of mentally and physically defective aliens, and in a general improvement in the character of our immigration.

Resolved: That copies of these resolutions be sent to the President of the United States, and to the members of the Committee on Immigration of the Senate.

(Signed)

Alexander E. Cance, Massachusetts Agricultural College, Amherst, Mass.
Irving Fisher, Yale University, New Haven, Conn.
Prescott F. Hall, Boston, Mass.
Robert DeC. Ward, Harvard University, Cambridge, Mass., Secretary.

April 24, 1914.

Association Meeting in August, 1915

Pursuant to an invitation from the American Association for the Advancement of Science, the American Genetic Association will hold its next annual meeting in connection with the meeting of the American Association at Berkeley, California, in the week of August 2–7, 1915. The program of the American Genetic Association will occupy a number of half days, to be selected later. Details will be in charge of the chairmen of the three committees on research.

International Genetics Conference

September, 1916, has been set as the date for the next International Genetics Congress, and it will be held in Berlin. This is the decision of the international committee which was named at the last conference (in Paris) to select the place of the next meeting. Arrangements for the meeting are being made by a Berlin committee consisting of Dr. Thiel Exzellenz (president of the German Gardening Society) chairman; Dr. Boenisch and Dr. Kniebe as representatives of the German Minister of the Interior; Dr. Scroter and Dr. Oldenburg as representatives of the Minister of Agriculture; Prof. Dr. Krüss representing the Minister of Education; Kammerherr von Freier-Hoppenrade (President of the German Agricultural Society), Oekonomierat Hosch (president of the German Breeding Association), L. Kühle, (representing the Society for the Improvement of German Plant-breeding), Prof. Dr. von Rümker and Prof. Dr. E. Baur. The latter two are in charge of business arrangements. The address of the committee is: Berlin N. 4, Invalidenstrasse 42, Kgl. Landwirthsch. Hochschule.

THE SAPPHIRE HOG

A New Breed in Process of Formation—Origin a Mixture, Selection the Method of Procedure—Approximation to Type Already Secured, and Large Percentage of Pigs Breeding True.

J. A. McLean

Head of Department of Animal Husbandry, Massachusetts Agricultural College, Amherst, Mass.

WE are rather loth to believe that there can be anything new under the sun. Especially is this true with live stock. Old things with valuable characteristics may be discovered in unfrequented corners of the earth and introduced, or new features not hitherto found in a particular breed may be embodied in its requirements. But live stock men, both breeders and teachers, have generally not advocated the creation of new types but have emphasized improvement of old stocks.

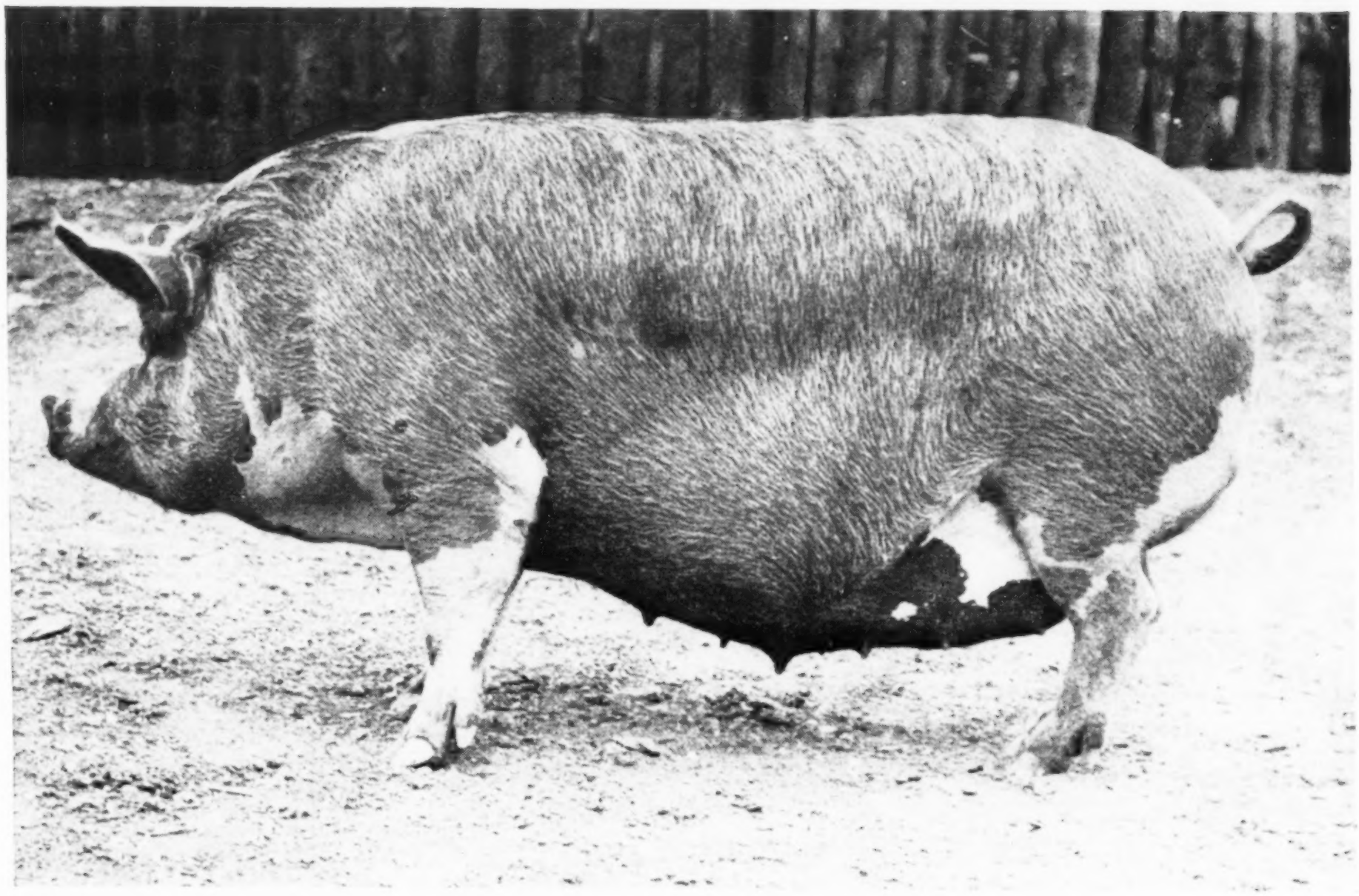
In plant breeding, hybridization has been one of the fruitful methods of producing new varieties, and plant breeders generally have not been slow to make use of this method of advancement. Is it not possible that animal breeders have worshipped pedigree too long and faithfully? Why might it not be possible, for instance, to combine the good qualities of the two breeds, Holsteins and Guernseys, and from them evolve a new breed distinctly superior to either? When we go back over the history of our breeds of horses, we find that each is of a more or less conglomerate origin; some of these breeds today permit to a certain extent, if they do not encourage, the introduction of outside blood. In most of our breeds of cattle the same conditions are found, as to origin. Crossbreeding, it is generally conceded, gives a greater vigor, a more rapid growth and consequently distinct market advantages. By careful selection, might not these features be retained in the succeeding generations from these hybrids? These are a few of the questions which demand a fair answer. Some experiment stations have undertaken to solve the many problems of this character, while a considerable number of breeders are also delving for the truth along these lines; and now one of the latter is coming to the surface with a so-called new breed of hogs.[1] Time will reveal the true merit of this breed. In the meantime, let us see what we can see.

THE ORIGIN OF A GENETIST.

About eight years ago, George C. Griffith, lawyer, Harvard graduate and younger scion of a Virginian family, was given but one more year's lease on life. He was enjoying his tenantry and, disliking very much to quit it so soon, he undertook to disappoint the prognostications of his medical servants. He bought a couple of New England stone piles with a very narrow valley and a stream between. He liked solitude, so he selected his hills three miles from town and well away from the main roads. Here he built a bungalow of most simple structure about the size of a box car, well up on the highest hill, from whose glass front he could see the mighty ocean. Here he began to win back life.

Since little of the land was arable, dairy cattle were scarcely feasible; poultry he disliked, and sheep were impracticable, so that swine production

[1]The breed was at first known as the Blue Hog. Mr. Griffith sent out an appeal far and wide for suggestions as to a permanent name, and that finally chosen was the idea of August Belmont of New York, himself a highly successful breeder as well as financier. The color, as livestock men will understand, is in fact a roan; the description of "blue-jay blue," which has been given in periodical literature, must be taken only as a figure of speech.



"VIRGINIA," A SAPPHIRE SOW

This animal, bred by the New England Live Stock Company of Peabody, Mass., weighed 408 pounds at 11 months. She is an excellent specimen of a new breed in the making. As Mr. McLean explains, this breed is made by selection from a mixture of Yorkshires, Hampshires, Berkshires, Essex and Chester Whites, and is now breeding fairly true, although the breeder finds it difficult to eliminate the white markings. (Fig. 8.)

became the only possible line of farm endeavor. A swill contract from a neighboring town gave a large supply of feed, so that this hog industry received a marked impetus. Within a couple of years, the man was well and found himself with a large hog business on his hands. He still retains his law office in Boston, but contrary to the usual practice, he finds time to visit that office only on Saturdays.

Almost from the very first Mr. Griffith had the distinct purpose of evolving a new breed of swine. In his first couple of years' work, with many hogs of all kinds, he saw many defects which helped to evolve the type of his new breed. Weak backs, pendulous bellies, broken down pasterns, heavy ears, were defects common and serious. The new breed should have none of these undesirable traits. Then, too, the color must be distinctive. Black, red, white—this had been the entire spectrum of hog shades. The new breed must have a new color, and Mr. Griffith chose blue from the very start, and without knowledge of the blue grays of the Shorthorn-Galloway cross. Lastly came the matter of head. The erect, trim ear of the Berkshire pleased, —but not the pug nose; long snouts were too often associated with narrow bodies, and narrowness between the eyes; while lopping ears obstructed the sight, which is surely not desirable. Thus has evolved briefly the conception of the type. The hogs of this breed shall be blue. They shall have trim bellies and be a trifle more upstanding than the average run of fat hogs; they shall have distinctly the fat hog form associated with excellent length of body; they shall have excellent strength of bone and be free from broken down pasterns; they shall mature earlier than any other breed of swine; they shall have erect, fine, rather small ears. The line from the poll to the end of the nose shall be medium short and the forehead

high; the top of the neck shall be slightly arched. They shall breed true to these characteristics. This, if you please, has been Mr. Griffith's conception of the breed before ever the Sapphire Hog was.

THE MEASURE OF SUCCESS.

To what extent has he succeeded? First let it be stated that the work is still in progress; none realizes better than the workman that his work is not complete. Yet he feels that much has been accomplished and that the end is in sight. There are now seven hundred Sapphire Hogs on his farm. He sells practically none of these, with certain exceptions. This gives him a large choice in selection of both sows and boars for breeding purposes. In these the color is variable, although the blue predominates. In a great many of these sapphires there is a white belt of variable width just back of the shoulder similar to that in the Hampshire. This white belt is accompanied by white on the belly, white nose and face, and white feet. Many lack the white belt but have the other white markings, while still others have blue body, legs and feet, but are lighter colored about the snout. The blue color seems to advance by degrees and the hardest white marking to eliminate is that of the snout, and next, that of the feet, and next to that the "Hampshire belt" and white belly. But there were a large number of "all blue" pigs, though generally with them the face was a trifle lighter in shade and in the forehead invariably there was a slightly darker spot. The shades of blue vary from quite light to almost black. This is due to the proportion of white to black hairs, for the blue color is due to the free intermixture over all parts of the body of black and white hairs. There is no shading of the individual hairs. The skin is pigmented wherever the roaning occurs, but is not as fully pigmented as is that of a pure black hog.

Several peculiar patterns occur in the uniformly blue pigs. There are some pigs which have a mackerel pattern in the blue, due to areas containing a larger proportion of black hairs. These present very much the same marbled appearance that is seen in some gray-colored cats. There are quite a few pigs that have distinct dark stripes about half an inch wide running lengthwise of the body, and from one to two inches apart. In some these stripes persist through life.

SOURCE OF THE NEW BREED.

The source from which this new breed is being evolved is conglomerate. Yorkshires medium and large, Hampshires, Berkshires, Essex, and Chester Whites have been freely used; Tamworth and Poland Chinas have not been used, though it is probable that some Duroc Jersey blood was mingled in the earliest crossing; but the pure black, the pure white, or the black and white breeds have been distinctly the basic stock. Pigs of good individuality have always been selected and while money has never been thrown away in high prices, yet it has never been withheld when a desirable hog for breeding purposes was found.

The first departure towards the blue color occurred about five years ago. This was a white sow with a very slight tendency to roaning upon her sides. Necessarily in the selection for color at first, some leniency in regard to other characters had to be exercised, but now only uniformly colored boars are used that have a good percentage of the other characters demanded. In the boars, the type of head, the strength of bone, the color and the conformation are all insisted upon. In the mature sows more variation still exists. One sees the old fashioned Berkshire snout and lop ear, and the white belt and other white markings quite generally.

There are a good many litters upon the place that are all blue, though they vary in the shading. A sapphire boar from sapphire dam and sire was mated to twenty-seven sows of other breeding carrying no sapphire tendency. Thirty per cent. of the offspring were sapphire and the highest per cent. in any one litter was 40.

It is to be expected that vigor and early maturity will appear in these

hybrids. Mr. Griffith has obtained sows weighing 600 pounds at 16 months, and thinks his hogs mature about two months earlier than any of the pure bred breeds which he carries on an equally large farm not far away.

"When we get through with them, they shall be uniform and breed true," was one of Mr. Griffith's last remarks to me, and one felt that if it can be accomplished at all, it will be. It might seem that perhaps these sapphire hogs can not be more "true blue" than can the Blue Andalusian fowls. We know that in certain fancy breeds of rabbits there are many wasters in every generation. Judging from a day's visit at the farm, this would not seem to be the case with the hogs, for from sapphire sows bred to sapphire boars, there were very few litters that carried pure whites or pure blacks. There were, however, litters from spotted sows that had only one cross of sapphire in the ancestry, that had in their litters pure blacks, spotted ones like the dam, and mackerel-marked sapphires.

There were other exceedingly interesting variations in color which, if they will breed true, will some day also appear as breeds; from a hereditary standpoint, they are now exceedingly interesting. There was, for instance, a Titian coated young sow of unusual beauty and a shade of color I have never seen in Tamworth or Duroc Jersey. There were a half dozen very uniformly and peculiarly marked black and white pigs, which promise interesting results.

No claim for immunity is made for the breed, but it is an interesting statement of fact that although these pigs, by the thousand for the last five years, have been raised almost entirely on city swill, yet there has never been any outbreak of cholera.

Such is the Sapphire Hog in the making.

NEW PUBLICATIONS

HANDBUCH DER LANDWIRTSCHAFTLICHEN PFLANZENZÜCHTING, Band I, Allgemeine Züchtungslehre (Handbook of Agricultural Plant-Breeding, Vol. I, General Principles of Breeding) by C. Fruwirth. Pp. xxiii+442, price M. 14. Berlin, Paul Parey, 1914.

The first volume of Professor Fruwirth's encyclopedic work on plant breeding has been rewritten and issued in its fourth edition. As a compendium of knowledge on every aspect of plant breeding, it stands unrivaled; it must be admitted that nothing equaling it has been produced in the English language. It is difficult to think of any subject connected with plant breeding which the author has not discussed fully and profoundly. Pains have been taken to keep the practical work of the breeder in mind, but from its nature, the volume is highly technical, and will be of value only to professional students of genetics. To the great body of them who are teaching genetics in colleges or practising it at experiment stations, the book would seem to be almost a necessary part of their equipment.

Vol. III, A. B. A. Reports, Wanted

A member of the American Genetic Association wants a copy of Vol. III, annual reports of the American Breeders' Association, to complete his file, and has expressed a willingness to pay $5 for it. Any member willing to dispose of his copy at this price is requested to notify the secretary. Copies of Vols. I, II and V are also in demand, and the secretary will be glad to learn of the whereabouts of any of these volumes which the owners are willing to relinquish.

BIOLOGICAL EUGENICS

Relation of Philanthropy and Medicine to Race Betterment—Study of Genetics Shows that no Race Can be Bred Immune to All Diseases or Defects—Nevertheless, Medicine and Charity Must Pay More Attention to Heredity[1]

LEON J. COLE,
Professor of Experimental Breeding, University of Wisconsin.

IN ACCEPTING the invitation to speak before this Conference on the subject of The Relation of Philanthropy and Medicine to Race Betterment, I wish to make it clear that I do so with no special knowledge of medicine or of sociology. But if by Race Betterment is meant in this instance the production of an inherently better race rather than simply the bettering of conditions—if it means biological improvement rather than social improvement—then I may perhaps avoid the charge of presumption, since neither medical science nor sociology has as yet amassed sufficient data for a very clear understanding of what their biological effects upon the race may be. Consequently the subject may be regarded to a considerable extent in the light of biological analogy, and if such facts as are known fit in with biological theory and deductions in other lines, we may from this gather some assurance that we may apply the reasoning of biology, in its narrower sense, to the destiny of mankind, which is, of course, a cognate field of biology in its broader meaning.

For we must not forget that man is still an animal, however much he may specialize socially; and although he may by his superior knowledge abrogate many of the laws which bind his more lowly kin, the bird, the fish, the maggot, or ameba, he cannot hope to escape from the operation of certain of nature's methods, and one of the most fundamental and tyrannical of these is that of reproduction. The heritage of society is passed in an uninterrupted flow from one generation to the next; but not so the biological inheritance, for between the individual of one generation and that of the next there is a rearrangement, a shuffling of the cards face down, leading to an indefiniteness of results which has long made this problem one of the most difficult of biological questions.

So it is as a biologist that I propose to discuss the question before us, and I believe you will agree that until we have enough facts to enable us to see definitely what medicine and philanthropy are actually doing for the race, we shall have to predict as best we can what they will probably do from our knowledge of general biological laws; and our predictions will have value directly in relation to the correctness and extent of our knowledge of these laws. This becomes at once apparent when we consider the diametrically opposed attitudes of certain biologists, sociologists and social reformers. One believes that the human race already possesses the potential factors for a richer and fuller life, that this more or less latent potentiality is rather universally distributed, at least within certain group limits,[2] and all that is needed is a better environment to bring it out. Such maintain that biological evolution has largely stopped in the case of civilized man, and that social evolution,

[1]Address (here abridged) delivered before First National Conference for Race Betterment, Battle Creek, Mich., January 8, 1914.

[2]See for example Smith, S. G., "Social Pathology," New York, 1911, section on Eugenics, especially pp. 308 and 309.

the evolution of the environment, has completely taken its place. Thus Smith in his Social Pathology, asserts that while "Charles Darwin may learn important lessons from pigeons and pigs, and a brood of lesser men may talk about human marriage in the terms of the stock farm, . . . the men of our generation who are studying the problems at closer range will more and more discuss them in terms of social psychology."[3] Another holds that evolution and selection, or evolution by selection, is in effect as always; that the potentialities of individuals differ, and that they develop differentially according to this inherited potentiality and to the limiting influence of the environment. Furthermore, that such individuals as are able to survive the environment and to produce offspring, bequeath to their successors only that which they themselves inherently possessed. Or still others, while believing that Natural Selection is biologically operative, attribute to the environment an ameliorating effect upon the germ plasm, which means the "inheritance of acquired characters." When men differ to this extent in their interpretation of natural laws, is it surprising that they fail to agree on specific means for race betterment?

PHILANTHROPY AND MEDICINE.

At first thought it might seem odd that philanthropy and medicine should be classed together in a discussion of this nature. The former draws upon the resources of the individual, or of the state, if we use the somewhat broader word charities, while the latter is ordinarily a source of income and livelihood to the individual practicing it. In this sense the same might be said of agriculture or manufacture. But medicine and philanthropy have this in common—the one tends to relieve the want, the other the suffering, and both often to prolong the life of the recipient.[4] And for this last reason they are both of the same immediate eugenic importance. I shall therefore treat of them together in general, discussing specific instances from one or the other as the case may be.

Almsgiving and charity are as old as history, and it is generally conceded that these give advantage to the biologically and sociologically unfit which enable them to live longer and to propagate more than they normally would. But with one or two exceptions, until recently, no thought was given, so far as we know, to the possible influence of this upon the race. Nevertheless, to quote Warner,[5] "Plato, more than two thousand years ago, warned his countrymen of the degradation in store for any nation which perpetuated the unfit by allowing its citizens to breed from enervated stock; and he sketched for them an imaginary republic in which no considerations of inheritance, of family ties, or of pity were permitted to stand in the way of the elimination of the weak and the perfection of the race."

With the rise of the study of economics these questions often came to the fore, and then the whole matter was given a new turn by the revolutionary ideas of Natural Selection which permeated so many fields after Darwin's publication of the "Origin of Species." Biologists and others were not slow to apply the new ideas to man's racial development, and from this time really dates the period of active discussion, and often violent disagreement, on the relation of social advance to race improvement or degradation.

As social reformers were concerned with bettering the environment, a work which could often be seen to produce immediate and marked results in adding to the health and material comfort of the populace as a whole, the gradual almost complete acceptance by biologists of Weismann's doctrines as to the non-inheritability of environmentally produced modifications naturally led to a widening of the breach between those who placed their faith in social measures and those who foresaw the direful effects

[3] *Loc. cit.*, p. 304.

[4] "The most obvious result of charity as a selective force has been to lengthen the lives of the individuals cared for."—Warner, A. G., "American Charities," New York, 1908, p. 23.

[5] "American Charities," 1908, p. 20. See also, Pearson, K. "The Scope and Importance to the State of the Science of National Eugenics," Eugenics Lab. Lect. Series, I., 1909, pp. 23, 24.

of what they believed to be the increasingly disproportionate ratio of defective racial germ plasm. The social reformer was accused of being shortsighted, like a mariner driving his ship ahead because the wind is fair and the weather looks pleasant, but utterly regardless of hidden shoals. Or he might be likened to the unscientific farmer who, because a particular crop is profitable, grows it year after year in the same ground without rotation until the land is depleted or "sick" and will no longer produce. Or again, like the capitalist who razes the forests or despoils the earth of minerals with all thought to his present gain, and none for future generations.

On the other hand those who called attention to the biological consequences of the withdrawal of selection were called "dismal scientists" and alarmists; it was maintained that "the mutilation or destruction of the unfit would make society as a whole increasingly cruel. It would produce a despotism of pseudo-science that would be more crushing to all the gentler virtues of men than any political despotism ever known."[6]

WARNER'S ATTITUDE

Between the views outlined above we find that intermediate positions have been taken by a large group both of social workers and of biologists. A few examples may serve to illustrate. Warner, who during his short life was one of the foremost social workers in America, far-sighted and discriminating, though primarily interested in practical charities, clearly recognized the importance of heredity in racial progress. He nevertheless emphasizes the value to the race of altruistic sentiments, though he recognizes the necessity of prevention of multiplication of the unfit. Thus he says:[7] "Could we cheaply rid ourselves of incapables and close our hearts to the appeals of distress, we might never have the compulsion put upon us of seeking out the wiser plans, which may eventually give us a more uniformly healthy race. Extermination might be an easy cure for pauperism, but it would be a costly remedy biologically; and if we allow our instincts to compel us to forego the use of it, we may ultimately be driven to preventive measures." He is doubtful, however, as to the efficacy of sterilization, and is inclined to the view which is now gaining wide acceptance that the most efficacious remedy is going to be segregation. He points out that in many of our almshouses there are sometimes inadequate means of separating the sexes, and "the breeding of paupers goes on upon the premises," and even that "formal marriages between almshouse paupers have very frequently received the sanction of both church and state." He concludes his chapter with the following very sane statement:[8] "Certain it is that while charity may not cease to shield the children of misfortune, it must, to an ever increasing extent, reckon with the laws of heredity, and do what it can to check the spreading curse of race deterioration. The desire to prevent suffering must extend to the desire to prevent the suffering of unborn generations."

Among those who have in their treatment of this subject emphasized the importance of the Natural Selection viewpoint may be mentioned especially Herbert Spencer, Francis Galton and Karl Pearson, the director of the Galton Laboratory for National Eugenics, though many other names might be mentioned as well. The last named has turned the energies of his laboratory to studying by means of highly developed statistical methods the inheritance of various diatheses, traits and defects, as well as the effects of ameliorative measures. In his Cavendish Lecture for 1912, entitled "Darwinism, Medical Progress and Eugenics,"[9] we find his position well set forth. After marshalling the data of his laboratory to prove that "general health is inherited and that the infantile death-rate is selective," he sums

[6]Smith, "Social Pathology," 1911, p. 294.
[7]*Loc. cit.*, p. 25.
[8]*Loc. cit.*, p. 31.
[9]Eugenics Lab. Lect. Series, IX, 1912.

up so well that I cannot refrain from quoting. He says: " . . . these are individual illustrations of what is happening, because the intensive selection of the old days has been suspended. That suspension is partly due to medical progress; you are enabling the deformed to live, the blind to see, the weakling to survive—and it is partly due to the social provision made for these weaklings—the feeble-minded woman goes to the workhouse as a matter of course for her fourth or fifth illegitimate child, while the insane man, overcome by the strain of modern life, is fed up and restored for a time to his family and paternity. In our institutions we provide for the deaf-mute, the blind, the cripple, and render it relatively easy for the degenerate to mate and leave their like. In the old days, without these medical benefits and without these social provisions the hand of Nature fell heavily on the unfit. Such were numbered, as they are largely numbered now, among the unemployables; but there were no doctors to enable them to limp through life; no charities to take their offspring or provide for their own necessities. A petty theft meant the gallows, unemployment meant starvation, feeble-mindedness meant persecution and social expulsion; insanity meant confinement with no attempt at treatment. To the honour of the medical profession, to the credit of our social instincts, be it said, we have largely stopped all this. We have held out a helping hand to the weak, but at the same time we have to a large extent suspended the automatic action whereby a race progressed mentally and physically.

MEDICAL PROGRESS VS. EUGENICS.

"Surely here is an antinomy—a fundamental opposition between medical progress and the science of national eugenics, or race efficiency. Gentlemen, I venture to think it is an antinomy, and will remain one until the nation at large recognizes as a fundamental doctrine the principle that everyone, being born, has the right to live, but the right to live does not in itself convey the right to everyone to reproduce their kind.

"Our social instincts, our common humanity enforce upon us the conception that each person born has the right to live, yet this right essentially connotes a suspension of the full intensity of natural selection. Darwinism and medical progress are opposed forces, and we shall gain nothing by screening that fact, or, in opposition to ample evidence, asserting that Darwinism has no application to civilized man."

I have made these quotations frankly and at length because I believe they will show you, more faithfully than I could perhaps have done it in my own words, the positions held by various students of race progress and betterment. I believe that any reasonable person must agree with Pearson that in spite of the masking influence of the increasingly complex social heritage which is passed on from generation to generation in our customs, beliefs, books, laws—in fact in all our increasing knowledge of science and the arts—nevertheless biological inheritance is operating in man now on the same principles that it did when he swung the stone axe, or scuttled through the trees with his simian congeners. The detailed studies of individual lines of inheritance which have in recent years been made from the Mendelian viewpoint[10] leave no doubt of this. Furthermore, this being true, it must be conceded by all thinking persons at all conversant with biological principles that selection plays the same role in directing the course of heredity, that is the surviving line of germ plasm, that it always has. Note that I say *selection* here rather than *Natural Selection*, for the latter term is associated in many minds with the crude methods of Nature uninfluenced by sentient forces. Will anyone deny that the animal or plant breeder utilizes the same principles of selection in breeding his cattle or his corn that have in Nature brought about the evolution of one form from another? The difference is that instead of being *Natural* selection it is now *conscious*

[10]For a summary treatment of these see Davenport, C. B., "Heredity in Relation to Eugenics," New York, 1911.

selection on the part of the breeder, and he directs the processes of change, in so far as his art enables him, along the lines which his needs or his fancy direct.

Now as man's mental capacities began to develop the course of selection shifted increasingly on to these, and they became more and more important as his social relations and capacities grew. I am not prepared to assert that the minds of the highly civilized ancient peoples, such as the Greeks, the Egyptians, or even more remote cultures might not be capable of assimilating and utilizing to the full the complexities of our present social and political conditions, our inventions and our scientific knowledge—indeed recent Japanese history would be argument in favor of such a view; but certainly this cannot be said of the more primitive races, and therefore some mental evolution must be postulated from such a condition To my mind the course of evolution presents a picture somewhat like that of a small stream of water making its way down an almost level but slightly irregular surface. Tongues are sent out this way and that as slight depressions lead here and there, and at times a considerable course may be made more or less consistently; but then a higher obstruction is reached and a new course started, determined by the point of lowest level. No matter how well one branch has progressed, if another finds a lower spot it diverts the stream. Just so races and civilizations have arisen and prospered and flourished until others superior in brute strength, in organization, or in equipment in arms, have come in and superseded them.

DEFECTIVES GROW IN NUMBER.

Until social customs became comparatively highly developed individual physical prowess was as necessary to existence as among the lower animals. This was in the stage of individualism. With specialization, as particular classes in a community took up certain special tasks, and especially as armies were formed not including the total population, physical selection became relaxed for some of the individuals. These conditions have become more pronounced until modern philanthropy and medical science are bringing them to a point where they can no longer be ignored. Neither the greater diligence in seeking them out nor the fact that they remain in institutions for longer periods will account for the disproportionately increasing number of defectives and criminals in our population. This fact seems demonstrated and one does not merit the epithet of alarmist for pointing it out. And if true, must we not give thought to its remedy?

Just as, when the human race developed from the savage, artful means of preservation superseded purely physical, and as the breeder has replaced fortuitous natural selection by conscious selection, so I believe the time is at hand when mankind will find it necessary to substitute some form of *rational* selection for the hit-or-miss, happy-go-lucky way they have drifted along in the past. Exactly what this method shall be I do not think we are in a position at the present time to say. Two chief lines seem open, restrictive and constructive—sometimes called negative and positive eugenics. The quotations which have been made in the earlier part of this discourse show clearly, it seems to me, that the former measures may be adopted under certain conditions without doing violence to the finer instincts of the race, without in any way destroying or lessening altruism or humanitarianism. In our nation-wide agitation for conservation we are just beginning to realize our duty to future generations. The case is a close parallel, for we are saying that the material benefits of our forests, our minerals and our water power must be conserved for the benefit of all the people, and not reaped now to enrich a few individuals and to be passed on only to their families. Shall we have less foresight in the heritage of defectives and cripples that we pass on to the next and future generations? Is not the social reformer who does not take this into consideration spending all his thought on bettering the present generation, just as exhausting our national resources might enrich this generation but pauperize the next?

Now, if it is going to be necessary for us to practice some degree of rational selection, we must be sure that it is rational—it must be based upon positive knowledge. What has modern biological research to offer in the way of contribution to such knowledge? In the first place we can readily see that a large part of the disagreement which has been mentioned is due to difference in opinion as to the influence which the environment may have on the individual and on the offspring. It is the old question of Nature and Nurture. While I am free to admit that in its abstruse aspects this is one of the most difficult questions confronting the biologist, I believe that much unnecessary confusion and needless discussion has resulted from the tendency of writers to exaggerate their views either on the one side or the other, and not to accord the question fair treatment. When I am asked, as often happens, which I consider of greater importance, heredity or environment, I commonly give a Yankee reply by asking in return, Which is of more importance for sustaining life, food or air?

INFLUENCE OF ENVIRONMENT.

Although we may concede what is the almost universal biological opinion of today, that the effects of environment are not in the crude sense heritable, we must not, nevertheless, lose sight of the fact that the environment is a most important determining factor in evolution and in selection. This may perhaps best be illustrated by an example. Let us suppose two cows, one of which is inherently a low producer, and is incapable of producing any considerable quantity of milk beyond that necessary to raise her calf. The other, on the other hand, has inherited the capacity to produce a large quantity of milk under certain conditions, namely proper feeding, care and handling. Now let us first consider these animals under, say, range conditions, where they receive no special care, and where they have to hustle for their own maintenance. So far as milk production is concerned they will measure up about the same—each will produce enough to raise her calf and no more—and very likely the inherently low-producer will be at an advantage under these more severe conditions. But now take the two animals and place them in a modern dairy with scientifically prepared rations, and the best treatment that modern dairy practice can provide. What is the result? The animal which inherited the capacity to respond to such treatment does respond at once by a sustained increase in the flow of milk; but the other does not. The former was hampered by conditions in the first place, but the latter is now absolutely prevented by her nature from the possibility of a response to the improved conditions. We see therefore that these conditions were necessary to make apparent the differences which existed in the hereditary make-up of the two animals. Is not the same true of the human race? It is only by giving opportunity to all, that we may know which are capable of profiting by that opportunity. The good environment then is necessary for differentiation, and without differentiation how may we hope to make selection?

Two other biological concepts are of importance. These have grown out of recent Mendelian investigations. The first is the idea of hypothetical factors, which are definite heritable units, and upon the presence of one or more of which all the characters of an organism depend. Since the factors behave for the most part independently in inheritance, the problem of handling them in selection becomes an extremely complex one. Where only two factors are concerned, any desired combination as to their presence or absence may be expected in at least one of sixteen individuals in the second generation. But as the number of factors to be dealt with increases, the number of individuals necessary to give all the combinations increases at a most disproportionate rate, as is indicated in the following table, which shows the number of individuals which according to expectation would be necessary to produce at least one individual with each

of the possible combinations under the conditions most favorable for bringing them about:

1 factor,	4	individuals.
2 factors,	16	"
3 "	64	"
4 "	256	"
10 "	1,048,576	"

Certain conditions, such for example as certain striking defects or abnormalities, may depend upon the presence or absence of a single factor, and it might be comparatively simple to deal with such cases singly. But the difficulty of dealing with any considerable number, especially in the case of man where conditions are very different from those of animal or plant experimentation, may be readily appreciated. It might be possible by prohibiting by law certain marriages and encouraging others to breed a race of mankind free from the diathesis toward a particular disease, let us say; but think of the number of diseases alone with which man has to contend and consider again the above table. And then tell me how soon eugenics is going to produce an "ideal race," made to order, as the newspapers would have us believe is its aim.

Such speculations may do for the visionary who likes to speculate what the world may be like a century or twenty centuries hence; but the practical eugenist is merely trying to determine how what knowledge we have gained to the present may be turned to the best advantage for race improvement as distinguished from individual amelioration. At the present time it would seem that we are in a position to apply certain phases of restrictive eugenics with comparative certainty of results, such for example as the cutting off of those definitely defective lines of germinal protoplasm which are beyond hope of hereditary improvement.

POSSIBILITY OF SEGREGATION.

As to the methods which shall be employed, it is coming, I think, to be generally conceded that permanent segregation, at least during the period of reproductive capacity, is going to prove the most feasible if not the most effective of restrictive eugenic measures. But we must be certain of whom it is necessary to segregate. The recent advance of knowledge in this line has been considerable, but it is only a beginning, and I must say that it is due more to the work of biologists than of physicians. Experimental breeding of plants and animals has supplied the keys which have unlocked some of the puzzles of human inheritance, but what we need now are more facts, the facts which can be gathered from the hospitals and asylums, from vital statistics and from the case records of practitioners. But these facts must be gathered with a fullness and accuracy, and with a view to the purpose they are to serve, which has not been customary in the past. It is a deplorable fact that comparatively few medical men have very clear ideas of heredity, or indeed evince much interest in the subject, and few realize its importance.

I have not had time in this discourse to touch upon specific diseases, operations and charitable procedures, and to discuss their relation to the question in hand as I should like to have done. It has no doubt occurred to many of you to ask, however, suppose we grant the necessity of restricting the reproduction of the obviously unfit, what about operations in other cases, the treatment of endemic and epidemic diseases, and the like? Is removing the appendix or the tonsils or the turbinal bones going to be to the race like the drug habit to the individual—once begun, having to be continued in ever-increasing doses? It may be. It is possible that the popular idea of the predicted "hairless, toothless race" may not be so far from the mark, or at least that this type shall increase in numbers unless sentiment against it becomes so strong as to become a selective factor. I wish merely to point out that the filling and crowning of our teeth is not going to insure better teeth for the next generation any more than wearing a set of false ones would; if selection is eliminated, the individuals of the next generation will have to take their chance of inheriting a better or a worse dental battery than their parents. My point is simply, that if the inheritance of the factors concerned were

understood, by selection of the parents good teeth could undoubtedly be insured to the next generation. But the question would have to be asked, would it be worth while? The breeder knows how hard it is to fix a number of characters at one time, and the student of genetics understands why; and while effort was being concentrated on the teeth other characters would run riot. The difficulties are further magnified by the fact, greatly emphasized in recent studies, that the way in which a character will be inherited often cannot be determined by its appearance in the individual. This is a fact which has been almost completely overlooked or ignored in the discussions of sociologists. So the conservatively inclined need not be alarmed that practical eugenics will do much more than to eliminate the more obviously unfit for some time to come.

If time permitted I should like to discuss the question of whether, in the case of certain specific diseases, such for example as tuberculosis, the greater promise for the race lay in selective heredity, or in environmental adjustments, such as prophylactic measures, antitoxins, treatment and the like. My feeling is that in most of these specific cases the race will find it most expedient to do as now, except in such diseases as denote general physical or mental defect or weakness. Take the case of cancer for example. Suppose it were found to be definitely inherited, but that medical science could find an easy and early diagnosis and certain cure. Would it not be simpler and easier to cure it as it appeared, even though its incidence should be even larger than now, than to cut off all affected lines of germ plasm? For certainly the stock that would be eliminated by such measures would be an inestimable loss to the world.

The very specificity of disease coupled with the difficulty of selecting for a large number of characters at once, and taken in connection with man's present cosmopolitanism, by which all diseases are becoming distributed all over the world within their possible ranges—all these factors make the breeding of a race of mankind immune to all, or even to a large number of diseases, a practical impossibility.

Eugenic selection must, I believe, for a long time be confined as I have said to cases of marked defect and weakness. In addition more study must be given to those influences which may weaken the germ plasm directly, such as alcohol. And medical science, rather than desisting, must push on, especially in the field of general prophylaxis, but with more thought to succeeding generations and the future of the race than it has given in the past. Philanthropy and charities cannot stop, but they must take more counsel of established sciences, and like medicine, give more thought to the future.

Left-Handedness

As left-handedness is an inherited character, apparently behaving as a Mendelian recessive, it is interesting to note the belief of some investigators that it is one of the stigmata of degeneracy. Bardeleben is quoted in German periodicals as saying:

"That a few great men, such as Leonardo da Vinci, were left-handed, does not neutralize the prevalent belief—in all ages—that left-handedness implies a sub-standard subject. The percentage of left-handed recruits is but 6.8; of school children somewhat higher. These figures are very deceptive, however, for of the left-handed children who became right-handed, the percentage is some 26. This, added to the persistently left-handed, raises the original percentage of left-handed considerably."

After pointing out that the gibbon and orangoutang are as a rule right-handed, and the gorilla and chimpanzee left-handed, the speaker decided there was no evidence at all that a left-handed person was mentally or physically inferior.

THE ORIGIN OF DOMESTIC FOWL

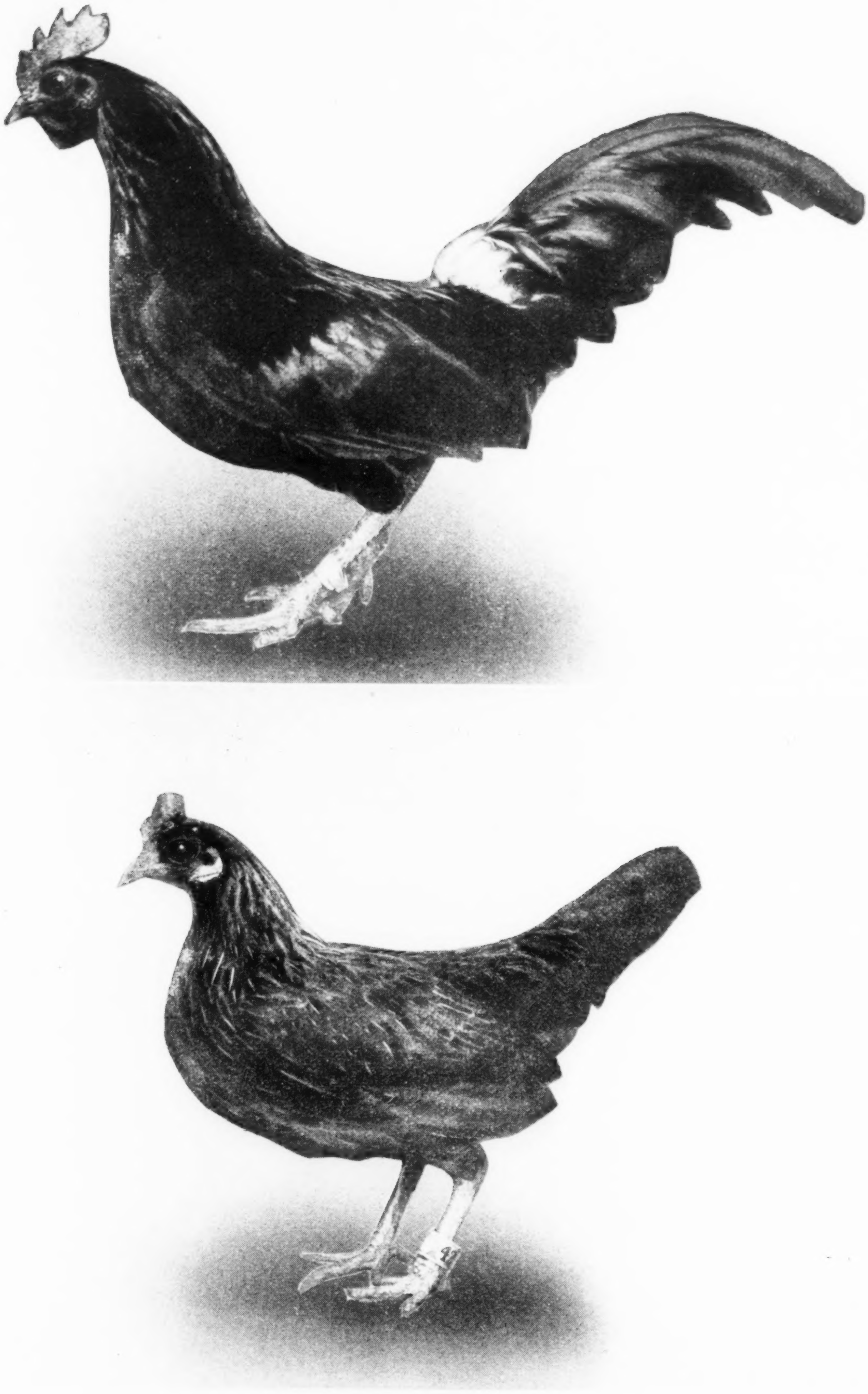
C. B. DAVENPORT
Cold Spring Harbor, Long Island, N. Y.

IT is commonly stated that the Jungle Fowl (*Gallus ferrugineus*) of India, southern China and the East Indies is the ancestor of our domestic fowl. But when we consider the great variety of characters that our domestic races exhibit it becomes hard for us to understand how they could have arisen from a single source. It is, indeed, pretty certain that two distinct species have contributed to the formation of our well known races:—one is the Jungle Fowl, which is still found wild, and the other is the unknown ancestor of the Aseel or Malay Fowl, probably the oldest fowl in domestication, for it has been bred for over 3000 years. It is still possible that the ancestor of this bird or its bones may be found in the interior of New Guinea, Borneo, or the Philippines.

The Aseel has many points of difference from the Jungle Fowl and brings in a whole set of characters that our domestic races have and the Jungle Fowl lacks. Thus the Jungle Fowl is a slender, agile bird with long wings, erect tail and a good flyer; while the Aseel is a very broad, heavy bird with short wings, drooping tail and unable to fly. The Jungle Fowl has a long, slender beak; that of the Aseel is short and thick. The comb of the former is single, high; that of the latter, triple (or "pea") and low. The former has slender, olive colored shanks; the latter thick and yellow shanks. The Jungle Fowl has a red eye; that of the Aseel is pearl colored. The Jungle Fowl has the well known English Black-breasted Red Game pattern; the Aseel is mottled. The Jungle Fowl is the foundation stock of our nervous, flighty, egg laying races—the Leghorn, Minorca, Spanish, Andalusian, etc.—the races that first spread over Europe, probably from the stock that was brought back from Persia by the expeditions of Alexander the Great. All of these races ordinarily carry the determiner of the Jungle type of coloration. Representatives of the Aseel type (which had long been established in Eastern India and China) were brought to America, becoming the ancestors of the Asiatic breeds and the fine, general-purpose breeds—the Plymouth Rocks, Wyandottes, Orpingtons, etc. Such do not regularly carry the Jungle type of color pattern. In one case, on the contrary,—namely in the Buff Cochins,—they introduced a new kind of color which (arisen in China 1500 years ago) has never been produced independently since. The fowl of the Aseel type are poor egg layers but their stocky build and great size make them unrivalled as table birds.

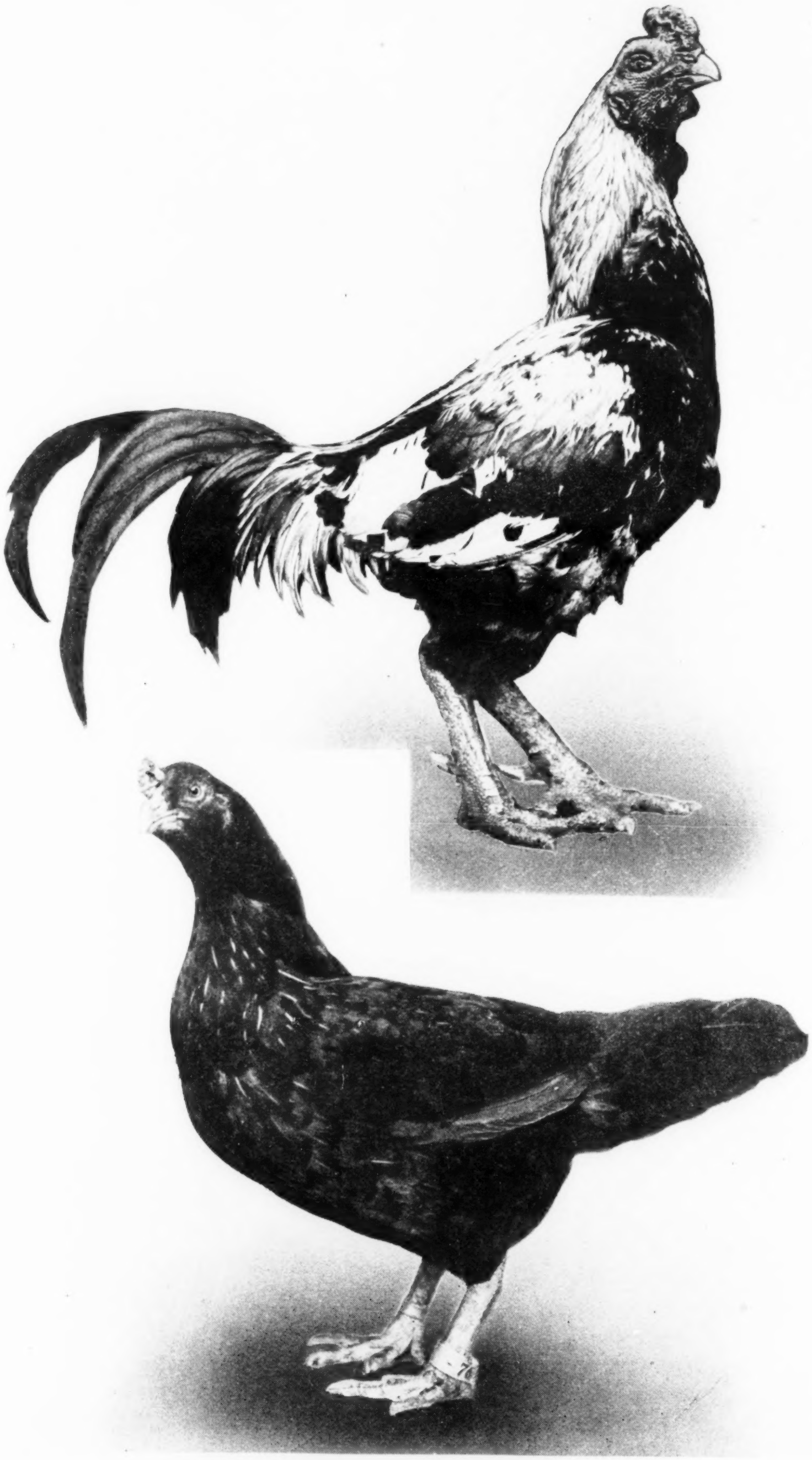
Racial Origin of Successful Americans

Dr. Frederick Adams Woods, chairman of the research committee in eugenics of this Association, writes in the Popular Science Monthly (April, 1914) on "The Racial Origin of Successful Americans." His study is confined to men of distinction or high official position in the four largest cities of the United States. He finds that those of English and Scotch ancestry are distinctly in possession of the leading places, at least from the standpoint of being widely known; and, in proportion to their number, the Anglo-Saxons are from three to ten times as likely as are the other races to achieve national distinction in the United States at present.



THE INDO-MALAYAN JUNGLE FOWL

Male above, female below, Note the slender form, the high, single comb, the long beak, the erect tail, the long wings and the nervous attitude, in comparison with the corresponding characteristicts of the Aseel. Between them, these two breeds supply all the characters shown in the many modern breeds of poultry, in Dr. Davenport's opinion; but the Jungle Fowl alone, which was formerly considered to be the ancestor of all modern breeds, is not able to account for them all. (Fig. 9.)



THE ASEEL OR MALAY FOWL

Above, a male. Note the stocky build and broad chest, the pea comb and overhanging brows, the short, heavy beak, the absence of marked wattles, the place of which is taken by a median "dewlap"; the short wings, drooping tail, stocky feet and short toes. The plumage is mottled and the hackle and saddle feathers are without red lacing. Below, a female: note the shafting (as in the Jungle Fowl), but the absence of mossiness on the wing feathers. (Fig. 10.)

RESULTS OF EARLY MARRIAGE

Does It Lead to the Production of Desirable Children, or of Mediocrities?—Need for Facts to Substantiate Theories—Reward Offered for Production of Cases Where Rapid Breeding Led to Good Results from Intellectual Point of View.

CASPER L. REDFIELD, *Chicago, Ill.*

MUCH has been said in advocacy of earlier marriages of our superior men and women for the purpose of improving the race by producing more numerous progeny from that class of people. A recent example is the article by Professor Roswell H. Johnson in the Journal of Heredity (Vol. 5, p. 102).

He says that "we *must* have our superior men marrying earlier, even at the cost of their early efficiency." Also, that we should "cease prolonging the educational period past the early twenties," and that our present practice of delaying marriages by extending education into post-graduate studies "cannot go on without serious loss to the race." To illustrate his point Professor Johnson furnishes a diagram showing the great increase in population coming from reproducing at the rate of four generations per century as against reproducing at the rate of three generations in the same time. He says:

> "Suppose a generation to be 25 years or 33 1-3 years respectively in two different stocks, and that all persons marry and each couple have four surviving children, or two for each parent. The result is that the 25-year stock constitutes two-thirds of the population at the end of a century."

The object of reproducing at the rate of four generations to the century is, of course, to produce superior individuals and increase the relative number of them in the entire population. Well, I will donate one hundred dollars to the treasury of the American Genetic Association if it can be shown that any superior individual ever was produced by breeding human beings as rapidly as four generations in a century. It is only necessary to find some superior individual from the intellectual standpoint whose date of birth is not more than one hundred years after the average date of birth of his sixteen great-great-grandparents. Any one of the 2,000 or 3,000 intellectually eminent men known to history, who comes in the four-generations-to-the-century class, will draw the hundred dollars.

To make the matter interesting and easy, I will be satisfied to give the one hundred dollars if there can be found more than three cases in which the intellectually superior person has as many as four generations in a century in the tail-male line alone. The three cases are an allowance of about one-tenth of one per cent. for errors in records or possible cases in which the putative father is not the real father.

In the northern part of the United States, and in the central and western part of Europe, the average time for three generations in the tail-male line is approximately 97 years. It is much less in most other parts of the world. In three generations of ancestors there are one father, two grandfathers and four great-grandfathers—a total of seven males. In any case in which the average age of these males was 33 1-3 years or less at the time the succeeding persons in the pedigree were born, the final product would be in the three-generations-to-the-century class—males only considered. It will be evident that much more than one-half of all people come within the three-generations-to-the-century class as thus defined.

Now raising the standard of superior individuals to the exceptionally great men such as Aristotle, Augustus, Newton, Bacon, Faraday, Franklin, Humboldt, Cuvier, Darwin, etc., of whom there are some two or three hundred known to history, I will give a second

one hundred dollars to the treasury of the American Genetic Association if a single one of them can be found in this three-generations-to-the-century class. Cyclopedias, biographies and biographical dictionaries give ample data for investigating more than a hundred of these cases.

The time limit on both of these offers will be December 31, 1914.

While I have investigated from many angles the question of the effect of age of parents on the offspring, I have never done the specific work called for by this offer. I am satisfied, from my general investigations on the subject, that no great man could have been produced under such conditions; but the person who hunts for the individuals designated will do something a little different from anything I have ever done. If the men are found, I will not regret the $200. I make the offer because I consider the problem involved to be of the highest importance, not only in eugenics, but in breeding any kind of animals.

For the purpose of general information and comparison, I append a table showing the distribution of births for two generations in the male line. It shows the ages of 2,564 grandfathers when grandsons were born, and the numbers of grandsons born at different ages of grandfathers. The figures were compiled from printed genealogies of New England families; and it will be admitted that the generations there are longer than they are in many parts of the world. Even there, it is evident that the general average of generations is more than three to a century. We should expect, on the laws of chance, that the illustrious men would fall in this class, in many cases at least. If they do not, there must be something wrong with such views as those expressed by Professor Johnson. If they do, someone can secure a contribution of $200 to the American Genetic Association by bringing forward the necessary data.

Ages of G. Fathers	No. of G. Sons	Ages of G. Fathers	No. of G. Sons	Ages of G. Fathers	No. of G. Sons	Ages of G. Fathers	No. of G. Sons
40	1	56	73	71	70	86	15
41	1	57	76	72	73	87	17
42	2	58	87	73	64	88	12
43	3	59	76	74	58	89	9
44	8	60	96	75	66	90	12
45	12	61	90	76	48	91	9
46	23	62	86	77	50	92	2
47	23	63	92	78	38	93	2
48	33	64	104	79	47	94	4
49	32	65	89	80	36	95	4
50	40	66	91	81	42	96	1
51	52	67	85	82	22	97	0
52	56	68	76	83	27	98	3
53	58	69	90	84	19	99	0
54	74	70	74	85	22	100	9
55	75						

Average for 2 generations $\frac{167330}{2564} = 65.26$ years.

The Eugenic Ideal

The Founder of the Christian religion said, "I am come that ye might have life, and that ye might have it more abundantly." It is higher and more abundant life that is the eugenic ideal. Progress I define as the emergence and increasing dominance of the mind. Of progress, thus conceived, man is the highest fruit hitherto. He is also its appointed agent, and eugenics is his instrument.—C. W. Saleeby: Parenthood and Race Culture (1909).

THE JABOTICABA

Interesting Brazilian Fruit Little Studied but Presents Possibilities to Plant Breeders—Causes of its Cauliflory—Variation and Hybridization Under Cultivation.[1]

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AMONG the many interesting indigenous fruits of central and southern Brazil, few create so strong an impression on the newcomer as the jaboticaba, not only because of its habit of producing its delicious fruit upon the trunk of the tree from the ground up, but also because of the unusual beauty of its symmetrical, dense, umbrageous head of light-green foliage, which entitles it to a place among the best ornamental trees of the region.

In spite of the popularity of the jaboticaba, which extends to all classes of Brazilians, and the fact that it has been cultivated for generations, the botany of this interesting fruit still remains in a state of confusion. As a general thing all jaboticabas are referred by horticulturists to *Myrciaria cauliflora* Berg, yet Berg[2] distinguished and defined three species, *M. cauliflora*, *M. trunciflora*, and *M. jaboticaba*, whose fruits are all known under the name of jaboticaba. Tavares, who gives a key for distinguishing these three species,[3] adds a footnote to the effect that the diagnostic characters will only serve to distinguish trees growing spontaneously in the forests, since culture produces marked variation from the typical characters, and in addition some of the cultivated varieties are the result of crosses between the different species. Barbosa Rodrigues,[4] another Brazilian authority, mentions two different species of *Myrciaria* whose fruits are known under the name of jaboticaba, distinguishing them by the fact that the fruit of *M. jaboticaba* is small and produced upon a short peduncle, while that of *M. cauliflora* is larger, and sessile; in addition the leaves of the former are larger than those of the latter.

To the student attempting to identify a jaboticaba found growing in a garden, the difficulties are numerous, and the whole subject seems involved in hopeless confusion. Not only must he deal with species, but the presence of horticultural varieties must be taken into account, in addition to the possibility of crosses between the different species, as mentioned by Tavares.

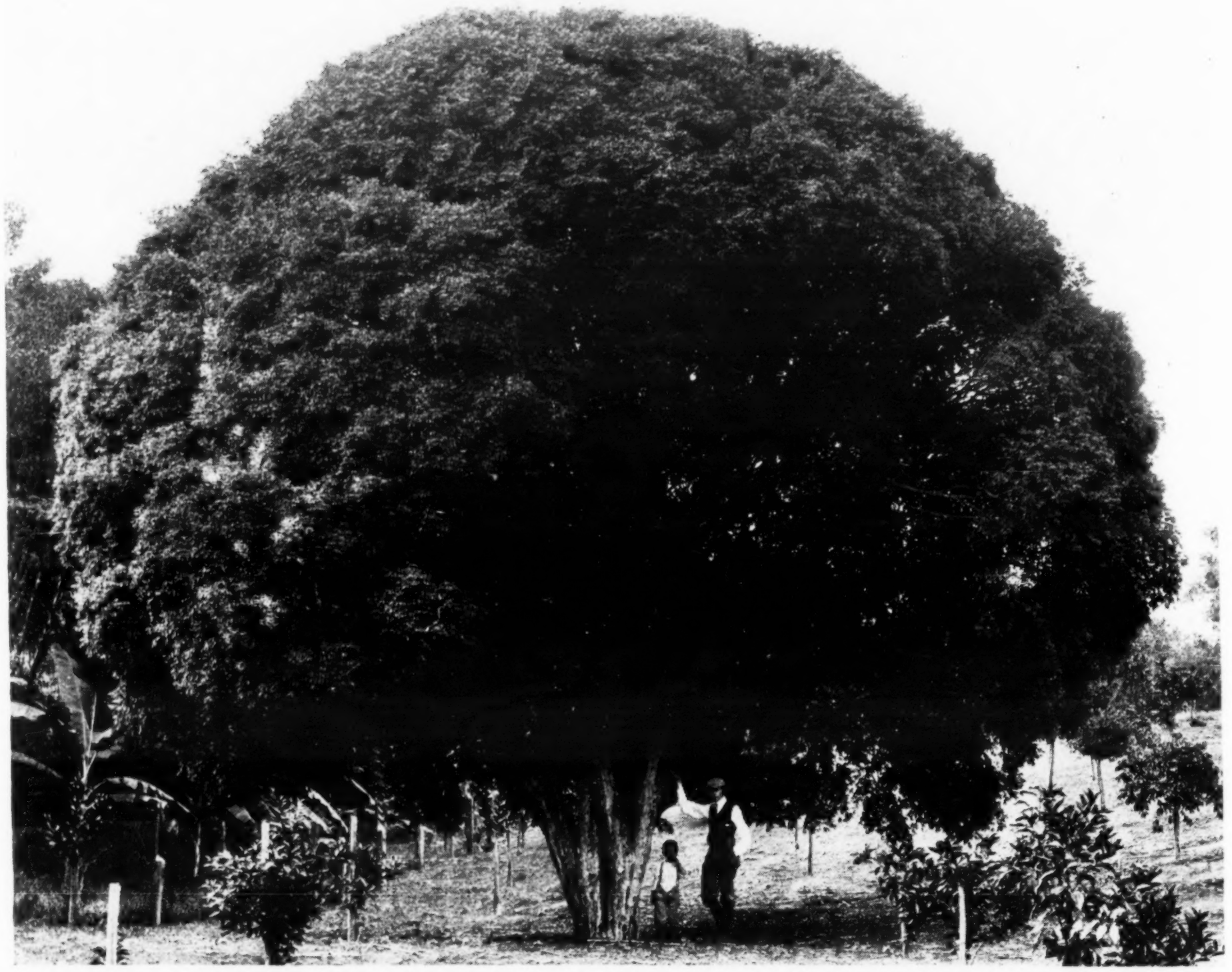
[1]The data contained in this article were collected on a recent trip of agricultural exploration in Brazil, in company with A. D. Shamel and P. H. Dorsett of the U. S. Department of Agriculture.

[2]In Martius, Flora Brasiliensis, Vol. 14, Pt. 1, p. 362. 1857-59.

[3]Tavares, Prof. Joaquim da Silva, in Broteria, Vol. X, Fasc. VI, p. 422. Bahia, Brazil and Salamanca, Spain, 1912. This key is as follows:

1. Peduncles of flowers and fruits quite long. Indigenous to Minas Geraes ..... *Myrciaria trunciflora* Berg
   Peduncles short ..... 2.
2. Leaves lanceolate or ovate-lanceolate, with the base obtuse. Calyx lobes ovate obtuse, ciliated. Indigenous to São Paulo and Rio de Janeiro ..... *M. jaboticaba* Berg.
3. Leaves lanceolate, with the base acute. Calyx lobes lanceolate, acute, ciliated. Indigenous to Rio de Janeiro and Minas Geraes ..... *M. cauliflora* Berg.

[4]Barbosa Rodrigues, J., Hortus Fluminensis, pp. 220-221, Rio de Janeiro, 1893.



A JABOTICABA TREE

One of the handsomest trees of Brazil, and highly prized on account of its delicious fruit. It seems to be adapted to a wide range of distribution in the tropics. (Fig. 11.)

GEOGRAPHIC DISTRIBUTION.

The geographic distribution of the jaboticaba is rather wide, ranging from Rio Grande do Sul on the south to Minas Geraes on the north, and from the Atlantic ocean to Goyaz and Matto Grosso on the west, a larger area than one would at first imagine from the propinquity of these states on the map. Outside of this region occasional trees are found in cultivation, as at Bahia, where the plant does not seem to be at home, however, and is rarely grown. Around the city of Rio de Janeiro the jaboticaba is one of the features of gardens and orchards, its dense, dome-shaped head of foliage, of an unusual shade of light green, marking it off from other fruit trees and making it a feature of the landscape. Not only single trees, but small orchards, sometimes an acre or more in extent, are not infrequent, being more common, perhaps, in the state of Minas Geraes than near the city of Rio. The esteem in which the jaboticaba is held by the Brazilians is attested by these orchard plantings, for in a country where the culture of tree fruits as a whole has not reached the stage where regular orchard plantings for commercial purposes are commonly made, the presence of a planting of four or five hundred trees of one variety proves the popularity of that fruit to be exceptional.

From the level of the sea the zone of the jaboticaba extends to altitudes of 3,000 feet or even more. At Petropolis and Nova Friburgo it grows and fruits well, as it does at Barbacena, in Minas Geraes, where the altitude is given as 1,168 meters. In this section of Brazil, however, the winters are not very cold

FRUIT GROWING ON LARGE BRANCHES

The berries are produced on every part, from exposed roots to the ends of small branches. Many tropical plants bear fruit on the old wood, while the habit is relatively rare in temperate regions; it seems possible that this habit is due to the softness of the bark, rather than to any adaptation caused by Natural Selection. (Fig. 12.)

even at such altitudes, and it is doubtful if the tree will withstand much frost. At Lavras, in Minas Geraes, ice is said to form occasionally, although the temperature for the last two years has not gone lower than 33° F., according to the observations of C. C. Knight of the Escola Agricola; in this region the jaboticaba must be given first place among fruits.

The name jaboticaba is a word of Tupi origin, derived, according to Martius[5], from *jabotim*, meaning turtle, the name signifying "like turtle fat," probably referring to the appearance and consistency of the pulp of the fruit.

[5]Beitrage zur Ethnographie und Sprachenkunde Amerikas zumal Brasiliens, Vol. II, p. 397, Leipsig, 1867.

Two spellings are current in Brazil at the present time, jaboticaba and jabuticaba being considered equally correct by some authorities, while others recognize jabuticaba as the best form. The word is usually pronounced by Brazilians zha-bu-ti-ca-ba, with slight stress on the fourth syllable. To designate the tree the suffix -eira is added, making the word jaboticabeira, or jaboticaba tree.

TREE LITTLE STUDIED.

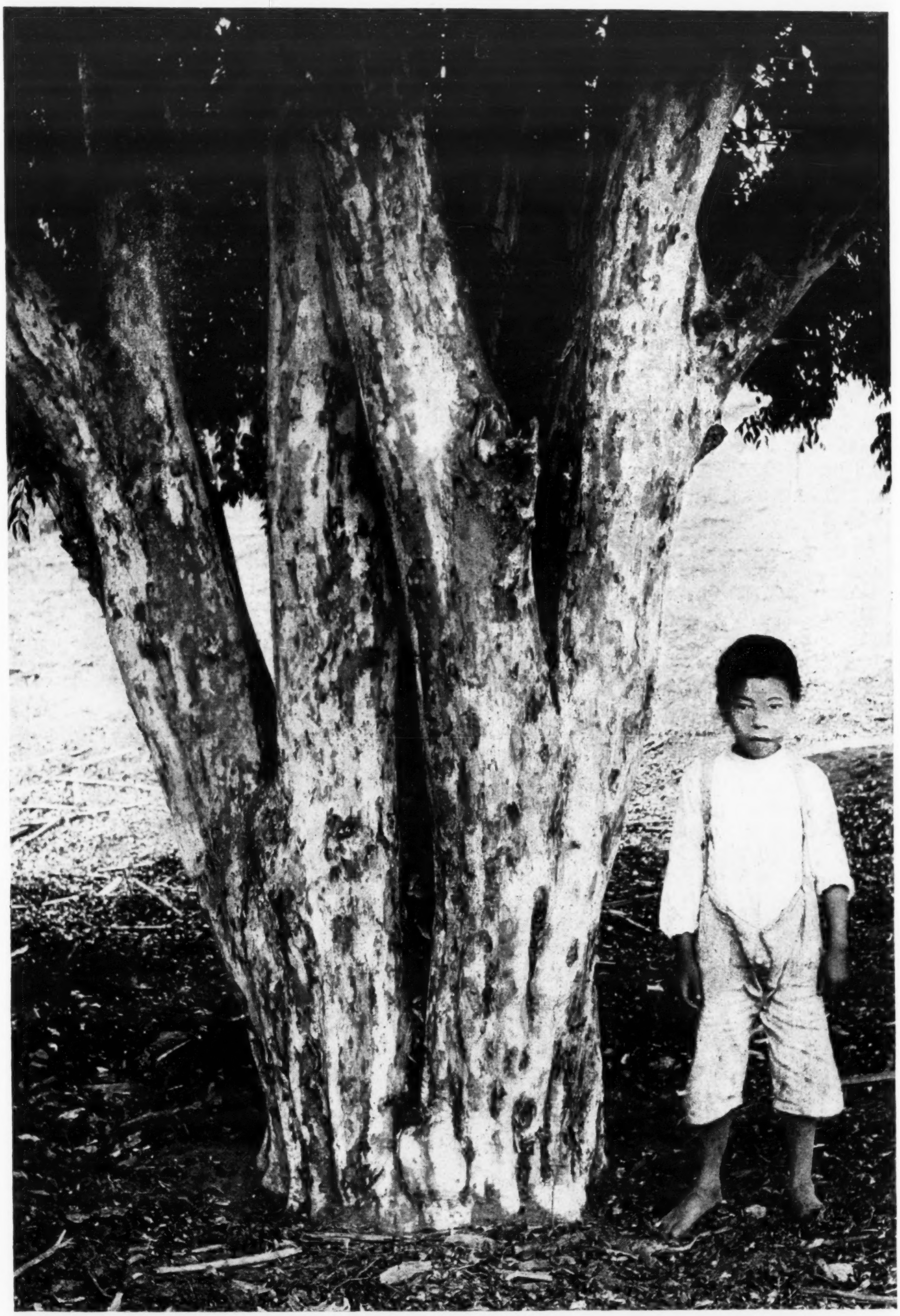
References to the jaboticaba in scientific literature are fewer than one would expect, considering the frequency with which the tree occurs in a large section of Brazil. One of the earliest and most interesting athough erroneous accounts is that given by Piso[6] in 1658, who says "It is a tall, erect, and elegant tree, bearing extensive branches; it bears an ash-colored fruit the size of a lemon, with sweet juice, and a very thin skin like that of very ripe grapes. It is wholesome and agreeable, especially to persons suffering from fever. It bears no flowers, but fruits from the bark, from the lowest root to the topmost branch and throughout the entire tree, close together in masses, so that the tree looks like one huge bunch of grapes, rather than a tree. A certain species of it grows in the forests of Pagi Tahuçurana, but bears fewer fruits as compared with the others. The natives express a sweet and delicate wine from it, which quickly ferments and turns into vinegar unless drunk. Both these trees are found in the vast forests of the interior, and are common in the prefecture of São Vicente, according to Emmanuel de Moraes. I must confess that I myself have never seen it, although I sought so elegant a tree with a good deal of diligence in the inland forests."

Barbosa Rodrigues considered the jaboticaba tree the most handsome of all the Myrtaceae. Under favorable conditions it grows to a height of 35 or 40 feet, the trunk nearly always branching close to the ground. The persistent leaves are opposite, ovate-elliptical to lanceolate, acute at the apex, generally glabrous, with the margins entire. In length they vary from three-fourths of an inch to over three inches, the size of the leaf being one of the characters by which the natives usually distinguish the different horticultural forms. The flowers are small, white, produced in clusters on the bark from the base of the trunk to the ends of the small branches, sometimes so thick as almost to hide the trunk from view. In form they resemble those of the myrtle, with four small petals and a prominent cluster of stamens. The normal season of flowering is said to vary with the different species; in the case of *M. cauliflora* Barbosa Rodrigues gives it as May in Rio de Janeiro, and in *M. jaboticaba* September. It is a common occurrence, however, for the trees to flower and fruit several times during the year, when they are in cultivation and supplied with an abundance of water.

DESCRIPTION OF THE FRUIT.

The fruit, which develops rapidly and ripens within two or three months after the time of flowering, is round or slightly oblate, half an inch to an inch and a half in diameter, deep, glossy maroon purple in color, crowned with a small disc at the apex. While sessile or nearly so in *M. cauliflora*, in *M. jaboticaba* the fruits are produced upon slender peduncles not over one inch in length. Between the two extremes in size there are all gradations, the fruits of *M. cauliflora*, which are considered the largest, frequently averaging about an inch in diameter as seen in the markets. The skin is thicker than that of the grape, and considerably tougher; it contains, beside coloring matters, a large amount of tannin. The translucent, juicy pulp, white or tinged with rose, is of a most agreeable vinous flavor, suggestive of the *rotundifolia* type of grape; this similarity to the grape is not confined to the flavor alone, the external appearance, character of the flesh, the size and number of the seeds as well as the flavor all bearing such a striking resemblance to the grape as to have earned for the jaboticaba the title of "the grape of Brazil." The flavor,

[6]Gulielmi Pisonis Commentarium in Iacobi Bontii Historiae Naturalis et Medicae Indiae Orientalis, Liber VI, p. 121, Amsterdam, 1658.



TRUNK OF JABOTICABA TREE

When trunk as well as branches are loaded with fruit, the sight is so extraordinary as to have caused an imaginative writer of the seventeenth century to declare that it looked more like a huge bunch of grapes than a tree. (Fig. 13.)

naturally enough, varies considerably with the species or variety, and one not infrequently finds a jaboticaba which has the disagreeable resinous twang common to several of the myrtaceous fruits; this may be due, in many instances, to the condition of the fruit at the time of eating and not to the variety itself. A good jaboticaba is so thoroughly agreeable as to tempt one to keep on picking and eating the fruits indefinitely,—a temptation to which, it must be confessed, Brazilians often yield. The boys, especially, will spend hours searching out and eating the fruits, and their only complaint is that it is impossible to satisfy one's appetite with jaboticabas.

The seeds vary from one to four in number, and are not easily separated from the pulp. In form they are oval to almost round, somewhat compressed laterally, one-fourth to three-eighths of an inch in length. The seed coats are thin and membranous.

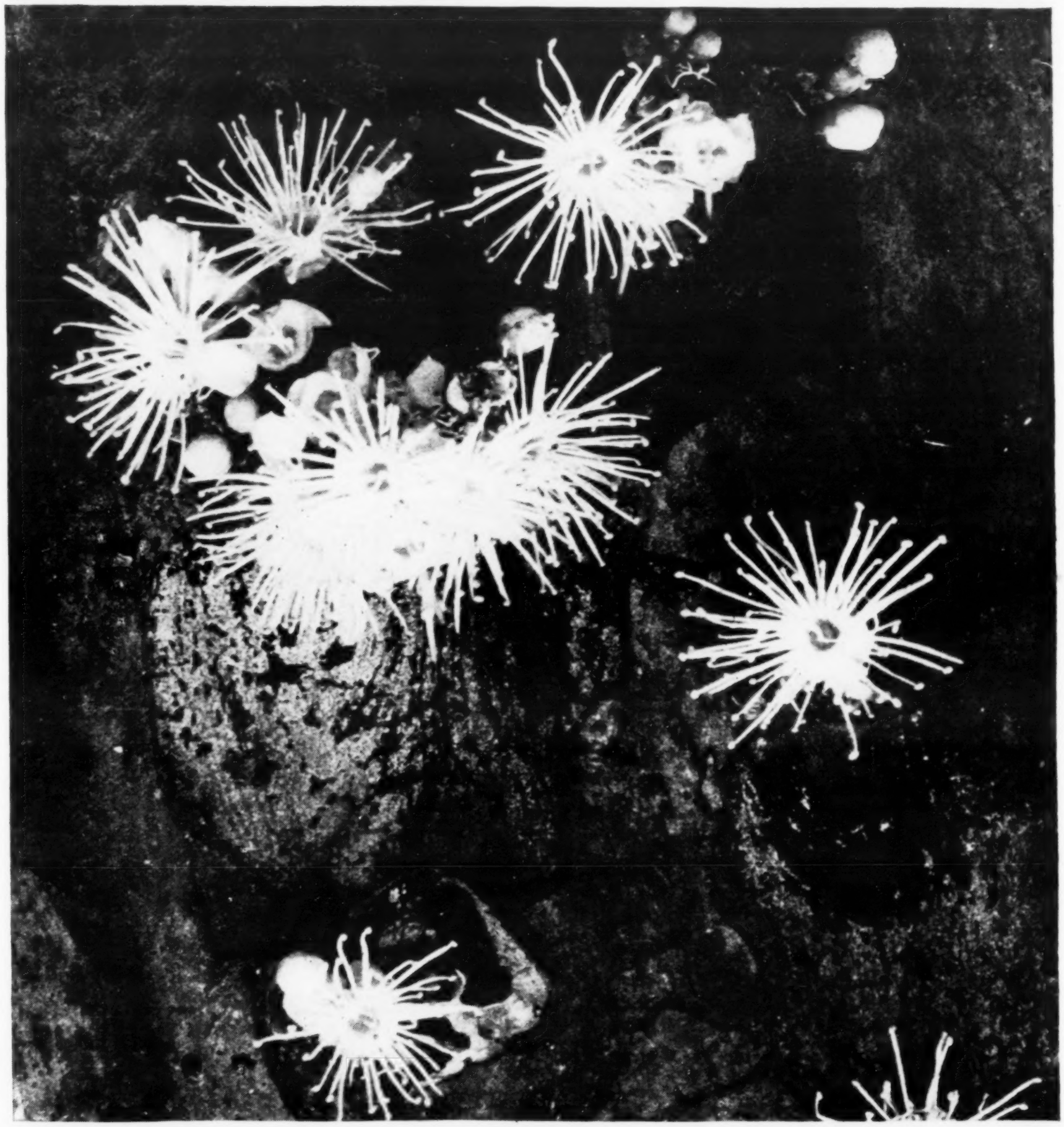
SPECIES AND VARIETIES.

A number of named varieties are known to the Brazilians, some of which are probably true species, others horticultural forms originating through seedling variation. The name jaboticaba, without any qualifying word, is considered to be properly applied only to *M. cauliflora*. In actual practice, however, this is not closely adhered to, since the natives of the lower classes use the word to designate the fruit of *M. jaboticaba* as well, although this latter is also known as jaboticaba de São Paulo, jaboticaba de cabinho, and jaboticaba do matto. Tavares mentions another species, *M. tenella* Berg, whose fruit is known as jaboticaba macia. The variety corôa, which is one of the commonest named forms recognized in Rio de Janeiro and Minas Geraes, can probably be referred to *M. cauliflora*. Another variety, murta, is equally well known, and has smaller leaves than corôa. No definite information concerning it is available, and as I have not seen it in fruit it is impossible for me to do more than venture a guess that it is another horticultural form of *M. cauliflora*. The native will often tell one that he has these two varieties in his garden, but when asked to define the difference between the two he is usually at a loss to name any distinguishing characteristic other than the size of the leaves. The variety branca is listed by one of the nurserymen in Rio de Janeiro, but no information concerning it is available other than that it is a small fruited variety. The name branca, meaning white, would indicate some difference in color from the common forms. Roxa, or red, is also applied to some jaboticabas as a varietal name, because of the fruit being lighter in color than usual.

The fruiting habits of the jaboticaba are worthy of more than passing notice. When heavily laden the tree is a curious sight. Not only is the trunk covered with clusters and masses of glistening jaboticabas, but the fruiting extends to the ends of the small branches, which all produce their share of the crop. When one stops to consider the small size of the fruits, and their abundance all over the tree, it is apparent that the number produced by a tree of large size must be enormous.

CAUSE OF CAULIFLORY.

Cauliflory—the producing of flowers upon the old wood—is not rare in tropical plants. It is difficult to see, however, of what advantage the characteristic can be to the jaboticaba, and what have been the reasons for its developing. Pollination has entered into the question, some authors having considered that the production of sessile flowers upon the old wood resulted in pollination by slugs. In the jaboticaba, however, this reason would not seem sufficient, since flowers are not only produced upon the trunk and large branches but upon the small branches and twigs as well. Neither is there any room for the argument that the fruits are too large and heavy to be borne upon the small branches and hence must be produced on the trunk, an explanation which has been offered to account for cauliflory in the jaca (*Artocarpus integrifolia* L., the jak of the Indo-Malayan region), whose fruits sometimes weigh as much as 40 pounds. Possibly



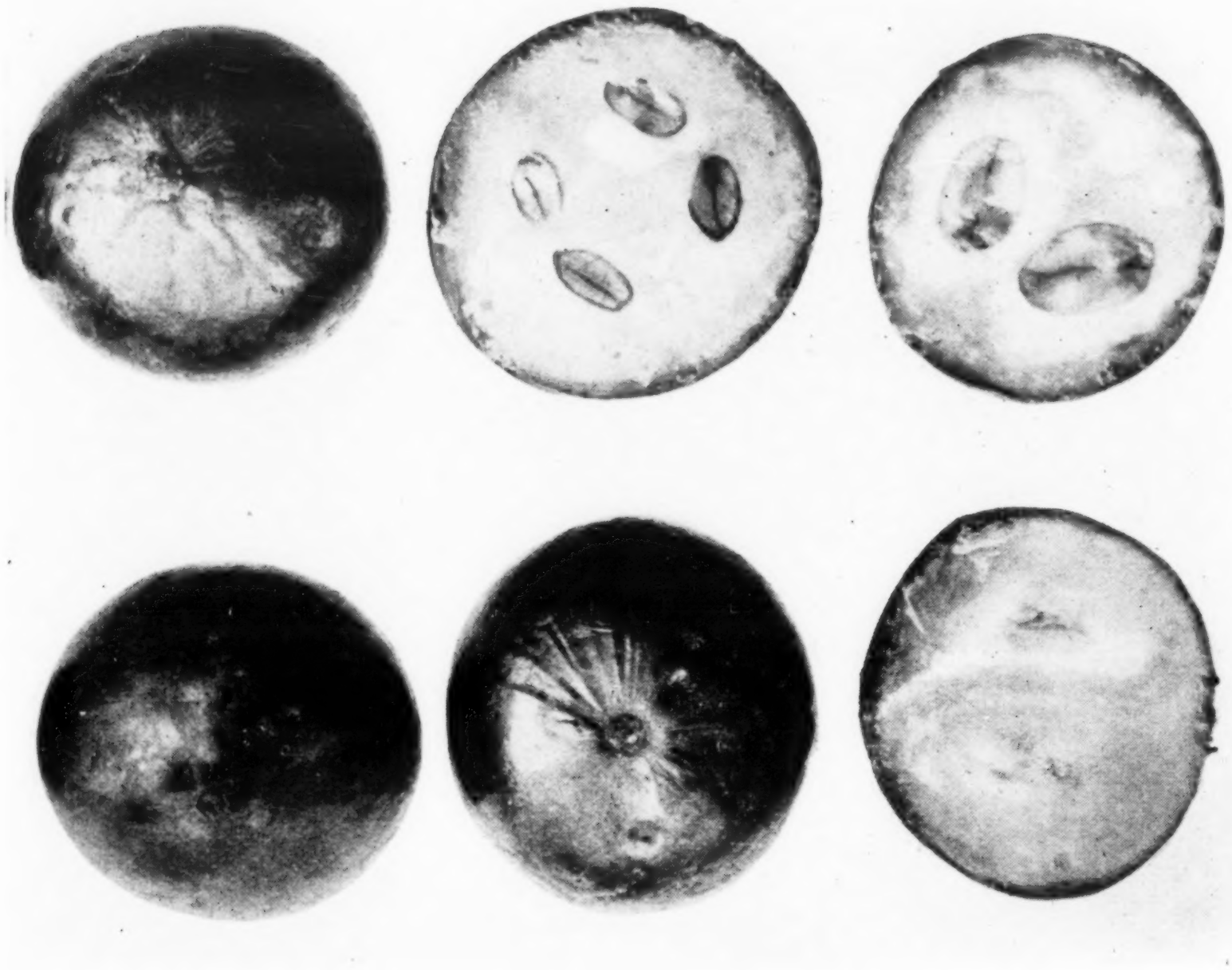
FLOWERS OF THE JABOTICABA

Twice natural size. They are similar to those of the myrtle, as the jaboticaba belongs to the order Myrtaceae. It has sometimes been supposed that the production of flowers on the trunk in this way was an adaptation to secure their pollination by crawling rather than by flying insects; but this argument seems to have no force in the present case, since flowers are produced on all parts of the tree. (Fig. 14.)

the explanation may be found in a statement of Schimper[7], who says "The question has often been raised why cauliflory is so much commoner in the tropics than in temperate zones, and the distribution has usually been associated with the conditions of pollination. To me it seems most probable that it is owing to the weaker development or less degree of toughness of the bark. This opinion is supported by the fact that in dry districts, where the bark is considerably developed and rich in fibers, cauliflory is very rare."

The season during which the jaboticaba ripens varies with the species and the location: sometimes, indeed, several crops a year are produced. The trees even flower and fruit during the winter months, in regions where the temperature does not go too low. Tavares considers humidity to be the essential factor, and states that the *fazendeiros* of São Paulo, who irrigate

[7]Schimper, A. F. W., Plant Geography upon a Physiological Basis, pp. 338-339, Oxford, 1903.



FRUITS OF MYRCIARIA CAULIFLORA

The largest of the jaboticabas. The pulp is juicy and in flavor greatly resembles the grape. In the markets of Rio de Janeiro such fruits sell for the equivalent of 25 cents a pound. Natural size. (Fig. 15.)

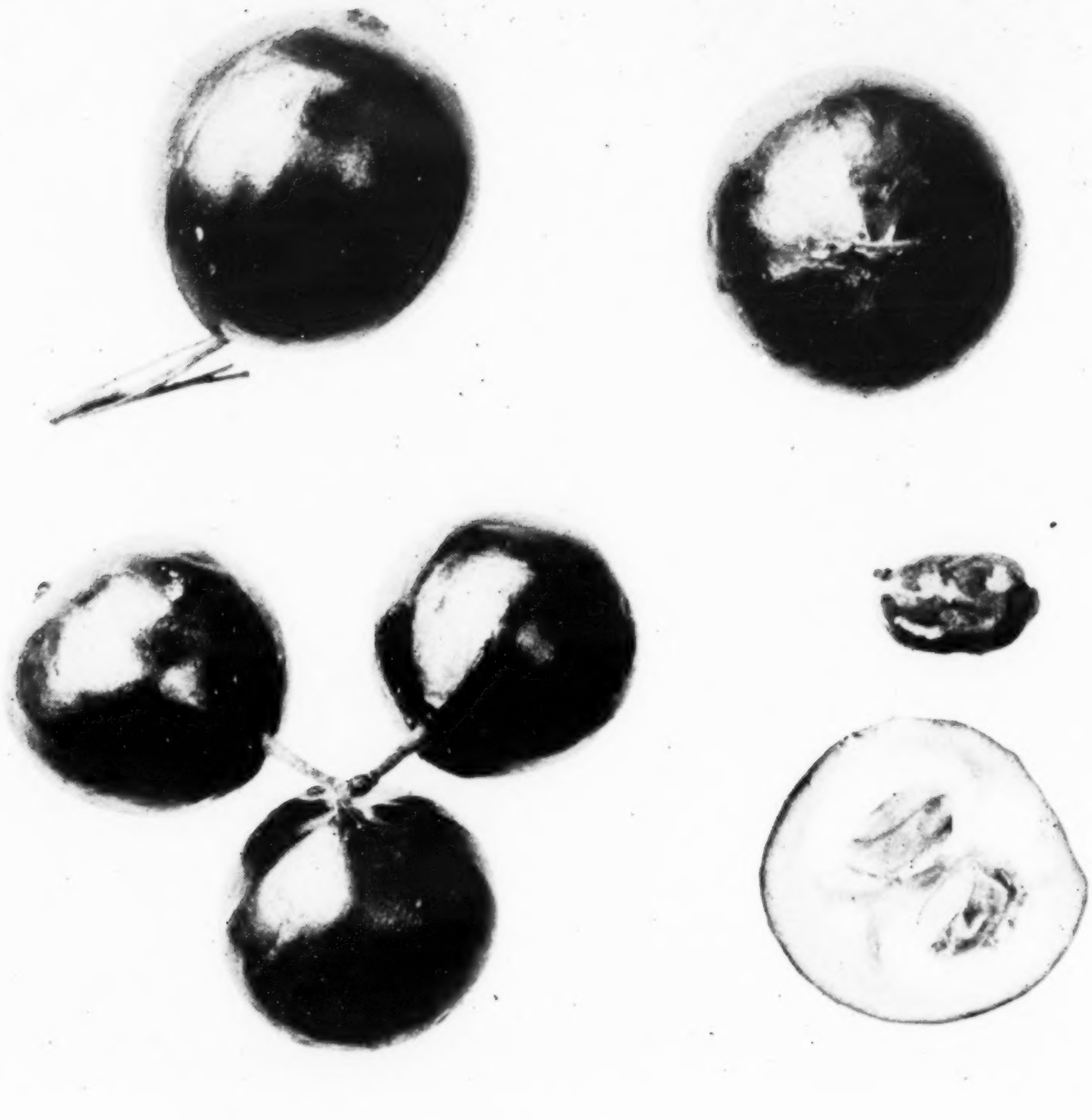
their trees at times when there is a scarcity of rain, succeed in having ripe jaboticabas throughout the year.

The methods used in marketing the fruit are somewhat primitive. Shipments are received in Rio de Janeiro from the interior, the fruit being packed in wooden boxes which originally contained two five-gallon cans of kerosene. No packing material is used, and the bulk being so great there is naturally much danger of the fruits being crushed and bruised in handling the boxes. If smaller packages were used much less injury would doubtless result; the tough skin of the jaboticaba enables it to be shipped considerable distances, provided a little care is used in packing. Since good jaboticabas retail in the markets of Rio de Janeiro at 1,500 reis (approximately 50 cents) a kilogram, there should be sufficient profit in handling this fruit to permit its being carefully packed and shipped in from distant points.

USES OF THE FRUIT.

While the jaboticaba is adapted to a number of different uses, at the present day practically all of the fruit seems to be consumed in the fresh state,—quite frequently direct from the tree. The almost passionate fondness which the Brazilians exhibit for this fruit seems to prevent their considering any other course than its immediate consumption the moment it is ripe enough to eat. By the aboriginal inhabitants of Brazil a wine was made which was held in high esteem. This wine is said to be made in small quantities at the present time, but it does not seem to rank as a commercial product. Jelly of excellent quality can also be made from the fruit. Frank R. Brainard, *chefe das culturas* of the Aprendizado Agricola at Barbacena, Minas Geraes, has recently experimented with this product to determine the best method of manufacture, and has found that the skins should be removed from about half of the fruits used, in order to prevent the jelly from having too strong a taste of tannin.

While the tree is said to succeed on any soil, it seems to prefer one that is rich and deep. Its growth is slow, six to eight years being required for it to



FRUITS OF MYRCIARIA JABOTICABA

These are distinguished from M. cauliflora by the presence of a slender stem, and are usually somewhat smaller in size. The color is a glossy purplish maroon. Jaboticabas are usually eaten out of hand, as grapes are in the United States. Natural size. (Fig. 16.)

come into bearing. In Brazilian orchards the trees are nearly always planted too close together, which prevents their attaining the large proportions they would otherwise reach. Frequently not more than 15 feet is allowed between the trees, whereas they should have at least 30. As previously stated, the jaboticaba withstands little frost, although it is without doubt hardier than many of the strictly tropical fruits, and adapted to cooler regions. In California some plants introduced about 10 years ago by Dr. F. Franceschi at Santa Barbara have made rather slow growth, and although at times slightly injured by the frost, give promise of being eventually successful in favored locations. Young trees in the U. S. Plant Introduction Garden at Miami, Florida, are doing well, and while it is yet too early to make any definite statement, they seem likely to prove adapted to this region.

In Brazil propagation seems to be exclusively by seed, although the foreman of one of the principal nurseries in Rio de Janeiro stated that he had successfully inarched young trees and considered this a desirable way to perpetuate choice varieties. Certain it is that some vegetative means of propagation must be used if improved varieties are to be established and perpetuated. The hard wood and thin bark will doubtless make budding difficult, but some form of grafting should prove entirely feasible.